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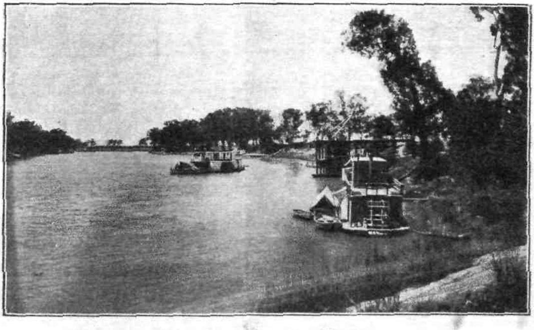
THE MALLEE FRONTAGE OF THE MURRAY RIVER.

An Undeveloped Province of Victoria.

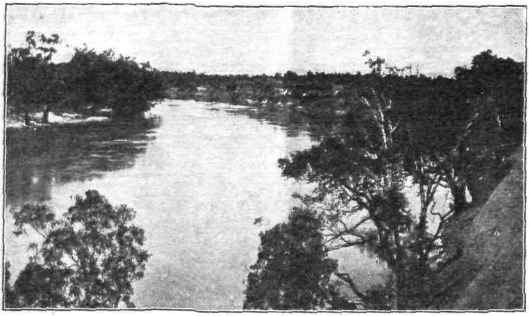
A. S. Kenyon, C.E.



RIVER MURRAY AT MILDURA.

From Nyah, a small township on the Murray River, some eighteen miles below Swan Hill, to the South Australian border, a distance of 450 miles by the course of the river, the Victorian bank is almost entirely without inhabitants. The one striking exception to this condition of loneliness and abandon is the irrigation colony of Mildura. Brought into being under the most glowing anticipations, nurtured in toil and trouble—particularly the latter—it has slowly achieved a large measure of success,

despite all adverse criticisms. The few miles of the frontage occupied —an area of less than 30,000 acres in all—support an industrious and prosperous population of 4,000 souls. This desirable result has been brought about by the intelligent use of water, otherwise flowing past wasted to the sea. There is nothing at all exceptional about Mildura itself. As a matter of fact, with the knowledge now acquired, many places, superior both in soil and in location, could be selected along the river. All along the lands adjoining the main stream is the best of soil lying parched and



RED CLIFFS, NEAR MILDURA (120-FT. HIGH).

unproductive, awaiting the application of the water which Nature has thoughtfully brought in abundance to the spot, for man to draw upon.

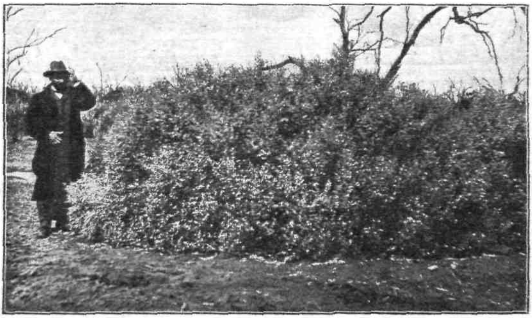
THE FRONTAGE LANDS ABOVE MILDURA.

With the river frontage itself must also be considered the immediately adjoining interior lands of the Mallee country. As will be shown in the course of this article, the interior lands are, for the purposes of profitable and permanent settlement, practically inseparable from the frontage. There are, in the frontage lands of the River Murray, two main classes, the river flats and the higher ground—the Mallee itself. The character of the country, both in regard to the Mallee and the flats, but particularly the latter, differs so much above and below Mildura, or rather the junction of the Darling River at Wentworth near by, that it becomes necessary to treat these parts separately. The frontage above Mildura will be first considered.

River Flats.

river flats comprise three different classes of soil and growth. The red gum flats, intersected by creeks and billabongs, and studded ·s of a more or less permanent character, grows little but red

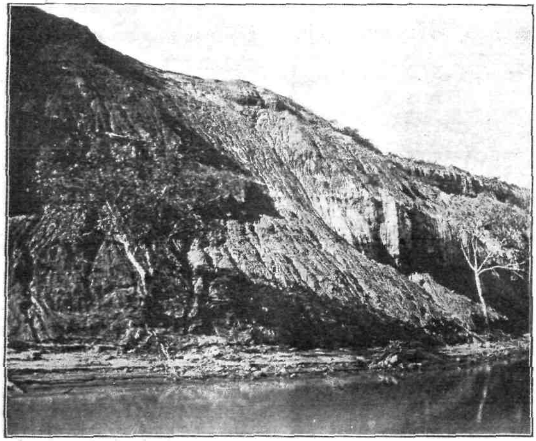
gum. The timber, though of large dimensions, is poor, and not fitted for use in engineering structures, though good enough for sleepers and house-building. The butts are generally covered with rough, black, persistent bark, a bad sign for the saw-miller. From many of them have been stripped sheets of bark to form canoes for the blackfellow, whose oven-mounds adjoining the high-flood mark are numerous. Wherever the red gum grows, it is safe to assert that annual flooding, and flooding for considerable periods is the rule. After prolonged flooding, a water grass



BOX FLATS, NARRUNG, WITH OLD MAN SALTBUSH.

comes up, which is an excellent fodder for sheep. It is, however, an exception. Apart from the lignum bushes, there is little feed of value. Pigs should do well, and in this direction, there appears a chance of profitably using these flats. Reclamation by levee works is not to be thought of; the consequent reduction in the flood-carrying section of the stream would tend to dangerously raise the level of floods. The locking of the river for the improvement of navigation will cause a considerable proportion of these flats to be submerged. The next division is the lower box flats, which are considerably higher than the red gum flats. They are of much older formation, and, although formerly traversed by abandoned courses of the river, the resulting billabongs have been silted up, mostly beyond recognition, by the wide spreading of the silt-laden flood waters. The lower box flats are subject to light and partial flooding only, save at very high stages of the river. When free from submergence for some years, a good season brings out a splendid growth of grass and edible bushes. Besides the ordinary native grasses, canary grass, wild oats, creeping saltbush, and many other varieties may be noted. The timber is almost wholly box, an occasional native willow being seen. The box, though on these flats of large size, is of little use except for fencing posts and firewood. The higher box flats form the third class. They are flooded, but rarely—at intervals of 20 to 30 years. The timber is smaller, of stunted, twisted habit, and very slow-growing. It is of service for

firewood only. Occasional pines and an odd clump of Mallee are seen. The grass is better and more abundant. The old man saltbush (*atriplex nummularium*) occurs abundantly in places where it has not been eaten out completely by over-stocking. None of the other perennial varieties of saltbush is to be found except in the interior, although the creeping saltbush (*atriplex semibaccatum*) is fairly plentiful. Both the higher and lower box flats are suitable for grazing and unsuited for cultivation. The somewhat heavy nature of the soil precludes successful working under the light rainfalls of the district without irrigation, while the fine soils of the Mallee alongside are more than sufficient for all the irrigation possible from the river, and at a far greater profit than the flats. The timber



CLIFFS ON THE MURRAY.

now on them with what may be grown in the future, will, however, become useful as a fuel supply for the numerous pumping plants which will eventually spring up along the river.

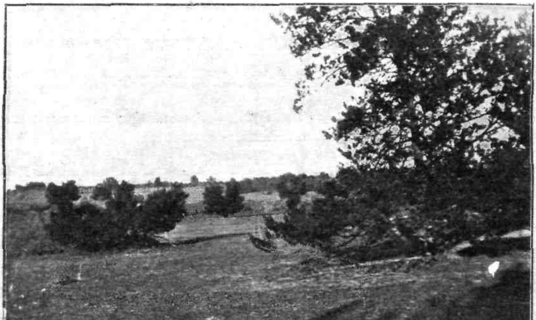
The Mallee Country.

The Mallee country also embraces three classes; the frontage lands of good, generally excellent, quality; the inferior interior lands—porcupine country; and the medium to good interior lands. The frontage varies from very narrow—a few chains only in width—to several miles across. It rises abruptly from the river or the billabongs, in cliffs 100 feet and

over in height, or slopes up gently from horse-shoe shaped flats until it reaches a level of 40 to 60 feet above the river. The vegetation sup-

OPEN MALLEE COUNTRY.

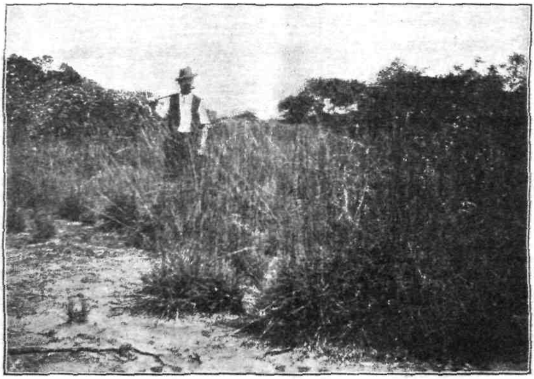
ported by it is mostly Mallee (*Eucalyptus dumosa, incrassata, Behriana,* &c.) of an open character, although at times fairly dense. There also



PINE GLADES.

occur in large forests, or scattered throughout, the Murray pine (*callitris cupressiformis*), belar, buloke (*casuarina glauca*), quandong, both bitter and

sweet (*santalum acuminatum*), needle bush (*hakea leucoptera*), myall, willow, cabbage, and many other trees and shrubs. The clearing of the denser parts, particularly the belar forests, will be a matter of some expense, cutting down and burning being worth up to 30s. per acre; but the rich soil thus made available will amply repay the outlay. Interspersed at frequent intervals are finely-grassed plains, or open spaces, up to several hundred acres in extent, which, dotted with shrub-like trees—trimmed off neatly on the lower edges by the stock—and occasional pines, with here and there a finely-foliaged red gum, present a sylvan aspect,



PORCUPINE GRASS RIDGES.

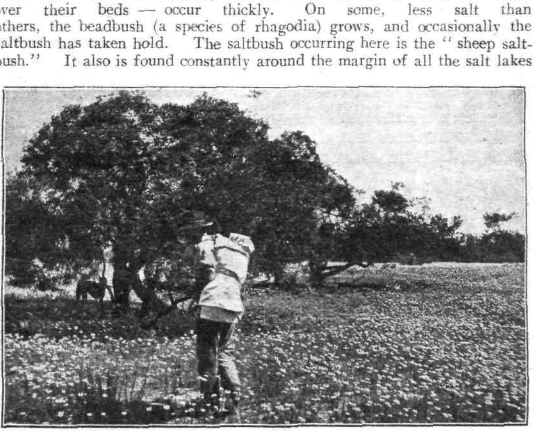
quite unlike the popular idea of the Mallee desert. In spring it would be a difficult task to find in any other part of the State such pleasant scenery.

The Interior Lands.

Behind the frontage fringe of good country lie the interior lands. Over a considerable portion there grows the porcupine or spinifex grass, a fairly reliable index to poor country. Fortunately the porcupine grass is mainly confined to the low sandy ridges which traverse the country from east to west, while the flats between are of good red soil, suitable for profitable wheat-growing. Phosphatic manures will be required, and systematic cultivation and fallowing. The absence of suitable catchments, and comparatively inferior soil render this area hardly fitted for settlement on the ordinary lines; but in conjunction with the more fertile lands of the Mallee fringe, it is capable of being utilized with success. There is also in the interior a considerable extent of medium, and in parts very good agricultural land.

THE NOWINGI COUNTRY.

At Nowingi, on the Mildura railway line, and extending westward from there to the 142nd meridian, is a large tract of country presenting several peculiar features. Large salt lakes, some as much as twenty miles in length—lakes in name only, having a thin skin of glistening white salt in the summer, and in the winter a film of water over their beds — occur thickly. On some, less salt than others, the beadbush (a species of rhagodia) grows, and occasionally the saltbush has taken hold. The saltbush occurring here is the "sheep saltbush." It also is found constantly around the margin of all the salt lakes



IN THE NOWINGI COUNTRY.

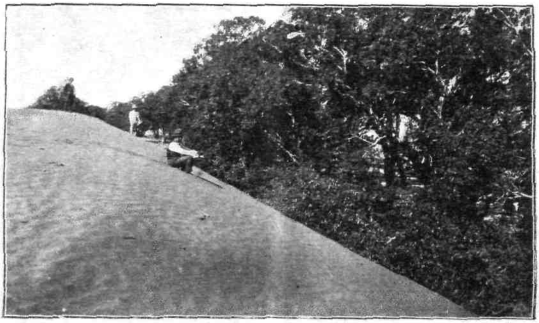
for a width of a few chains, and it grows largely amongst the Mallee bushes wherever they occur. Some large plains, which are probably, judging from the evidence of their margins, and by the occurrence of what were formerly islands, the beds of old salt lakes, are covered with the saltbush, to the exclusion of all other vegetation. A notable instance is the Raak Plain, of about 40,000 acres. On the high ground separating the lakes, magnificent belar forests appear with much sandalwood (*santalum persicarium*), pine, and other trees and shrubs. Considerable grassy plains occur with large clumps of tobacco bush, and immense fields of white and yellow everlastings. On the whole, very little mallee is to be met with. The fatal drawback to the settlement of the Nowingi country is the water supply. Good or fair catchments are fairly numerous; but good holding ground for the excavation of tanks is absent. Salt water is reached in a few feet at any good sites for tanks. It is proposed to work these lands in connexion with the frontage country at Carwarp—country of the usual frontage type, except that it is not so elevated above the river level as usual.

THE HATTAH AND OTHER FRESH-WATER LAKES.

Another characteristic feature of the interior country is also the occurrence of lakes, but this time fresh—when they have water in them. The

THE HATTAH LAKES—LAKE MOURNPOOL.

flood waters of the Murray, making their way over the flats, or through the billabongs and creeks, fill large depressions or lakes situated several



DRIFTING SAND.—LAKE MOURNPOOL.

miles back from the frontage. The Hattah lakes form an important series, there being about ten large lakes, a great number of small ones, and numerous box swamps. The good land immediately adjoining the lakes is

not of as great extent as usual, while it is of such a loose sandy nature without any intermixture of clay to cause coherence that, except under irrigation, the breaking up of its surface by cultivation will not be advisable. As far as can be judged in the absence of levels, the whole series of these lakes can be filled or topped up annually during the high river periods, without the expenditure of any great sums of money. In some of the larger lakes could be stored considerable volumes of water, while from others the water could be excluded, and their beds used for irrigation. The beds are composed of a considerable depth of black crumbly clayey soil, containing a fair amount of humus, and highly suitable for intense culture.

Making permanent the supplies in the lakes would increase the amount of frontage to water for settlement purposes, and at the same time bring the interior lands nearer water. Near Narrung, and about two and a half miles back from the river, across extensive higher box flats, is a lake of

A MOB OF STEERS AT BUMBANG.

about 500 acres in area, and capable, apparently, of holding 16 to 20 feet of water. Water gets in at long intervals, the last occasion being about twelve years back. It is surrounded by high ridges, clothed with pines. When seen last in November, a small flock of sheep and a large mob of emu were the sole inhabitants. The land immediately adjoining the lake—the same is the case for all lakes, whether salt or fresh—is of excellent quality, particularly on the northern and eastern shores. Small irrigation settlements could be established on any lake, filled regularly from the surplus or flood waters of the Murray, and after locking, this would be easy of achievement. They would be on a much smaller scale than Mildura; but would score on account of better soil and lower lifts for the pumped water.

BUMBANG.

The country lying in the embrace of the river, as it makes its great sweep from the Murrumbidgee junction round by Euston to the Coreena Bend, is known as Bumbang. The whole of it, amounting to over 80,000

acres, is of first-class quality, and could be cut up into comparatively small areas for wheat-growing alone. The vegetation is similar to the best of the frontage fringe, and the whole is well-grassed, large plains alternating with open country. Rolling downs impart a pleasing appearance to the scene. The height above summer level of the river varies from 60 to 100 feet. It is suitable for fattening lambs, as the autumn and spring grasses rarely fail, even with the low rainfall, the light, sandy soils responding readily to light rains. The pastoral lessee has some 3,000 acres under wheat, and is clearing a large area for further cropping, evidencing a considerable amount of faith in the profits of cereal growing up there. On the eastern boundary is another large lake—Lake Powell, or, as it is locally termed, Belcher's Lake. This might also be readily converted into a permanent storage, and form the nucleus of settlement. Probably no greater stretch than Bumbang of first-class land can be found in the State. All that is wanting to render it as valuable as any, is water. Failing that, and water for the irrigation of the whole area is too much to expect, much may be produced from it by up-to-date methods of cultivation and cropping.

DISEASES OF FARM ANIMALS.

S. S. Cameron, M.R.C.V.S.

III.—CAUSATION OF DISEASE.

(Continued from Page 253.)

TEMPERAMENT.

Except that nervous and skittish horses are more liable to accidents, and frequently exhibit a loss of appetite, purging, or other slight derangement after a fright, or abuse, or other excitement, it may be doubted whether temperament has as much influence on the causation of disease as is usually supposed. The idea that activity of the general or systemic circulation, which is said to be associated with high breeding and the sanguine temperament, predisposes to inflammatory diseases and congestions is not supported by experience in practice. In point of fact, congestions are more common in horses of languid disposition and circulation, and inflammation will more often supervene on the attack of a common cause in a fat, ill-conditioned horse with sluggish circulation than in a trained muscular horse, with heart and circulatory organs up to concert pitch. On the other hand, the tendency to dropsical swelling and puffiness of the extremities in coarse-bred horses, and which is put down to lymphatic temperament and sluggish circulation, is more reasonably accounted for by the anatomical features of the tissues concerned. The cow and sheep are considered to have a dull, lymphatic temperament, yet except during the occurrence of actual disease, these animals are singularly free from "filling" and puffiness of the legs, even when kept stall-tied for a lengthy time.

Pain may be felt more acutely by a horse of a highly nervous temperament than by a crossbred "slug"; but it by no means follows that the suffering of pain is made more pronouncedly manifest. In point of fact, the reverse is more often the case; and to operators of extended experience, the first violent plunge of the thoroughbred at the first cut of the scalpel, followed by the grim setting of the teeth and the dogged bearing of pain without further fuss, are evidences of "pluck" on which could almost be based an estimation of the animal's capacity for "seeing it out" at the end of a sternly-contested race. This capacity to bear pain without murmur is a feature in the high-bred one in marked contrast to the squealing and groaning, wriggling, and sweating and general cowardly behaviour which is kept up continuously by the underbred cur while under the knife.

SEX.

It is obvious that the anatomical variation of the sexes will account for the occurrence of disease in one sex, which cannot occur in the other; but apart from this it has been observed that in some few diseases to which both sexes are subject, notably roaring in horses and bladder affections, that the proportion of affected males is measurably greater than females.

The increased functional activity of the generative organs of females during pregnancy and the lactation period induces tendency to disease, and the alteration of the nutritive equilibrium which occurs at such times is sometimes responsible for grave derangement of the system. Mares "in season" are frequently subject to attacks of hysteria, and are not seldom the victims of accident.

AGE.

So important a factor is age in regard to the incidence of disease that the term "age period," has come to have considerable significance in the differential description of diseases. Thus the age period of tuberculosis in man is that of adolescence, or early maturity (between 18 and 25); while in cattle, tuberculosis is primarily a disease of advanced maturity or old age. Again, measles, acute rheumatism and cancer are associated in men with particular age periods, as are, in animals, white scour, distemper, rickets, black leg, and strangles with youth; milk fever, roaring, navicular disease, sidebones, and splints, with maturity or middle age; and indigestion, intestinal calculi, blindness, tumours, and degenerations with old age. Lambs and calves are liable to invasion of intestinal and lung worms, and other parasites which older animals of the species resist; and the period of dentition is frequently accompanied, especially in dogs, by serious nervous and digestive derangements amounting to disease. Decay, and unevenness of wear and growth of the teeth are accompaniments of old age in animals, and these, in turn, by preventing thorough and necessary mastication of the food, give rise to debility and various manifestations of indigestion, such as colic, diarrhœa and unthriftiness.

In considering age as a factor in disease, it is well to regard it always relatively. As some men are young at 60, and others old at 40, so with horses; the vim, energy, and "cockiness" of some old stagers over 20 should, if there was consciousness of the emotion, put to shame many a five-year-old.

PREVIOUS DISEASE.

Many instances can be cited of previous disease, whether general or local, predisposing to an attack of either the same disease or some other. After recovering from laryngitis, bronchitis, pneumonia, pleurisy or other disease of inflammatory type, the patient is always more liable to a second attack from an even less potent exciting cause. The disease leaves behind it the proverbial "weak spot," and it is often a long time before this predisposition to subsequent attack disappears. Weed, or "shot of grease" (*lymphangitis*) has a particular proneness to recur on the slightest provocation after a first attack.

Some diseases almost invariably occur as a sequel to others of a different type; to wit, chorea, or St. Vitus' dance, following on distemper in dogs, rheumatic affections of joints following on influenza, roaring succeeding strangles, and so on. Complications during the course of a disease are often simply the result of the action of a cause which, without the "weakening" produced by the already pre-existing disease, would be inoperative.

DIATHESIS.

This is a term used to indicate a constitutional peculiarity of individual animals, or of species of animals, in which liability to contract certain forms of disease is marked. In such animals or species, causes which would be trivial and ineffective in other animals or species, result in the development of serious conditions of disease. The rheumatic and tubercular diathesis are the most familiar examples in individual animals of this peculiar constitutional condition. In an animal possessing the rheumatic diathesis, a slight cold or chill will precipitate an acute attack of rheumatism, while in the tubercular diathesis, although the bacillus of tuberculosis must be present before the disease can develop, the animal seems to become an easy victim to its attack. Diathesis is often confounded with heredity, but the distinction will be seen when it is said that the tubercular diathesis is hereditary, while tuberculosis (the disease itself) is, with rare exceptions, not so; the disease is not inherited, but the tendency to it is.

As an illustration of diathesis occurring throughout a species, what has been termed the "ossific diathesis" of horses, may be mentioned. No other species of animal exhibits such a tendency to the formation of bony deposits and growths—splints, spavins, ringbones, and the like bony disease growths are practically peculiar to the horse tribe.

Some animals possess a diathesis, or idiosyncrasy, with regard to certain medicines; for example, an ordinary dose of, say, aloes, will produce most violent purging and bowel spasms in odd horses. In fact, it may be said generally that horses in Australia are much more intolerant of that drug than they are in Britain, and it is consequently used much more sparingly in veterinary practice here. Another familiar example of this unusual susceptibility to the action of a drug is the violent irritation and pain produced when turpentine is applied to the skin of the horse, whereas in the case of man the application has to be accompanied by pretty smart friction to produce even a glow or an uncomfortable degree of warmth.

HEREDITY.

The vulnerability to tubercle, which may be inherited, has already been referred to, and as with this disease so with roaring, broken wind, spavin curb, navicular disease, ringbone, cataract, and the majority of diseases that have hitherto been classed as hereditary, it is the *tendency to the disease* which is inherited, and not the disease itself.[1] That is to say, animals with such tendencies will develop such diseases on the incidence of slight exciting causes, whereas in other animals such causes would be ineffective. If such exciting causes are withheld, the hereditarily-disposed animal may escape the affection altogether. This is strikingly illustrated in the case of roarers, whose offspring, when bred and reared in a dry hot climate like that of India and Australia, seldom develop the disease, whereas in the damp chilly climate of the British Isles, such offspring almost inevitably succumb to the tendency, and develop into roarers. It will be inferred from this that roarers are rare in Australia, and, comparatively speaking, that is so. Similarly, navicular disease rarely develops in Australia in horses which would be considered in England hereditarily predisposed, because the exciting cause in the shape of hard macadamized road does not exist, except in the neighbourhood of large towns. When an inherited tendency to disease has not manifested itself by the development of that disease in a given animal, it often happens that in succeeding generations, on the occurrence of influences favorable to the development of the disease, it will be produced. It is frequently observed in regard to such diseases as ringbone, navicular disease, and cataract (blindness) in horses that the disease does not occur in the progeny until it reaches the age at which the parent became affected. In the case of the two former affections, this may simply mean that similar conditions of life experienced during the same age period, may produce similar results, but such an argument can scarcely apply in the case of cataract.

In-breeding tends to accentuate characteristics, and may occasionally be practised with advantage, but intimate knowledge of its laws is necessary to prevent deterioration of constitution. *Consanguinity*, which results from in-breeding, and by which is meant nearness of blood relationship, emphasizes the tendency to development of hereditary defects, so that where disease exists in a family, close breeding should be rigidly avoided. The bringing together of strains which each possess unsuitable characteristics or

[1] It may be well to qualify this statement somewhat in the case of tuberculosis, in spite of the now widely-held view that this disease is never inherited, for cases have been recorded of calves being born with the disease, and the following case investigated, and not previously recorded, is here given, to excite discussion among those who hold that such cases are congenital, and not inherited :—In a duck with generalized tuberculosis, the wall of the oviduct was the seat of extensive tuberculous invasion, some of the tubercules discharging into the oviduct, in which was impacted a concreted mass of egg substance. This consisted of a central yolky portion, enveloped by alternate and incomplete layers of hardened albumen and shell, evidently developed successively during the lengthened stay of the impacted mass. Imprisoned between the layers and between the innermost of them and the yolk tubercle bacilli were found, which had evidently been discharged from the tuberculous wall of the duct. It would appear from this that a naturally developed egg might easily become impregnated during its passage along the oviduct by bacilli from its walls, and the question arises whether the tuberculosis which would doubtless develop in the chick after hatching should be described as having been acquired or as having been transmitted hereditarily.—S.S.C.

a tendency to contract the same disease is very unwise for the same reason —the likelihood of such characteristics or tendencies being accentuated in the progeny.

Cross breeding will at first favour increase of vigour, but much harm may ensue through want of knowledge or appreciation of the effects of prepotency in sire or dam, or of influence of an adverse character arising from injudicious mating.

When disease is actually transmitted from parent to offspring before birth—as may occasionally be the case with strangles, anthrax, and some few other diseases—and is present in the offspring at or before birth, it is termed *congenital* disease, that is, a disease acquired from the parent by the offspring after conception, and during intra-uterine life.[1]

Defects of Conformation, which predispose to disease, are most surely transmitted to the progeny, especially by prepotent sires or dams; and while it is not necessary to risk an action for damages by actually naming sires that have proved useless on this account, most observers of stud racers will, without stretching their memories unduly, be able to call to mind many instances in which a horse of faulty conformation has managed to battle through a course of training and win races, and thereby gain a reputation, but whose progeny have been practically worthless, through inheritance of the defect which made their sire "difficult to train." One of the most conspicuous instances in recent years, is that of a placed horse in a *fin de siecle* Melbourne Cup, which, magnificently formed in all other respects, possessed pronouncedly upright pasterns. This defect caused his premature retirement from the turf, and though given excellent chances at the stud, his progeny have, almost without exception, been "tarred with the same brush," and unable, for that reason, to stand training.

FOOD.

On one hand excess of food, either in quantity or quality, may predispose an animal to indigestion, colic, congestion of the liver, and like derangements of the digestive functions, and on the other hand lack of food or starvation, by inducing debility, will lay the system open to the successful attack of germs and other direct causes of disease. Unsuitability of food is equally likely to pave the way for disease. Feeding on musty hay, for example, for a lengthened period will, if it does not actually cause the disease, at all events precipitate an attack of asthma or broken wind. New hay, and partially fermented chopped foods are notorious as causes of colic, "hoven," and other bowel disturbances.

In this country those derangements of the digestive tract, caused oftentimes by unsuitable or defective food, of which chronic indigestion and broken wind are a type, are comparatively rare. This is due indirectly

[1]It has recently become the fashion to say that all such diseases are "acquired," *i.e.*, acquired *in utero*, and not hereditary. To all intents and purposes, however, I think such cases come under the ordinarily understood interpretation of the term "hereditary"; and if that is conceded I fail to see the difference between a disease acquired in the womb before birth, and that acquired from the parent immediately after birth; so that, in the case of tuberculosis, which is doubtless not rarely acquired by the newly-born offspring from the mother through the milk, I am personally of opinion that it may, for practical purposes, and in the absence of artificial conditioning, be considered to be hereditary.—S.S.C

to the influence of climate. Throughout Australia, fodder of all kinds is usually harvested under circumstances that, with the exercise of ordinary care, preclude the likelihood of its being damaged, or rendered unwholesome to a disease exciting degree, as is often the case with the grass and cereal fodder crops in England during the broken-weather hay time and harvest seasons, so commonly experienced there. While the food of animals is thus mostly sound, it is of a character so monotonous as to account for a variation in type of many disorders. Seed-grass hay, so largely used throughout England as a staple food is, on account of the seasons, very difficult to grow as forage in Australia, and hay consisting solely of half-ripened cereals (oats or wheat) is the staple food all the year round, and takes the place of the naturally mixed diet which grass hay itself affords.

While it may be at once admitted that horses do not require that their food should be varied to the extent requisite in man or other omnivorous animals, all experience points to the advisability of an occasional change of food. A diet which is suitable in the depth of winter is not calculated to be health-maintaining during the excessive heat of summer, yet the wheaten or oaten hay or chaff ration is seldom altered; and if supplemented, it is by the addition of oats or bran by which the monotony is not varied. The want of variety is rarely relieved by the giving of carrots, or other alterative food, and it is very exceptional for barley, maize, beans, peas, or linseed foods to be used. At certain seasons green stuff may be given, but, consisting, as it usually does, of young oats, it is no change, such as an occasional feed of green vetches, peas, beans, or prairie grass would be.

WATER.

What has been written regarding food in excess or lack, may apply also to water, although animals will rarely take an excess of water if they are allowed continual access to it. On many extensive grazing areas throughout Australia, and particularly during drought periods, the only available supply of water is that contained in natural water-holes, or artificial tanks. Such stagnant water is always highly charged with vegetable growth, and often with the urine and excrement of animals which have unrestricted access to it. In hot weather it is likely to become putrid and filthy, and it forms an ideal developing medium for legions of animal parasites—fluke, tapeworms, and the like. Hence the extraordinary prevalence of intestinal and other parasites in Australian domestic animals, particularly dogs and sheep; and hence also the fact that, excepting Iceland only, hydatid disease in man is more prevalent than in any other country in the world.

Contaminated water, by virtue of the organic matters and microbes it contains, is often an exciting cause of disease. Indeed, there are grounds for believing that the influence of contaminated water in the propagation of various epizootic diseases, has not been given sufficient weight. From the known method of spread of typhoid fever in man, it may be very well argued that animal diseases of similar type are also frequently "waterborne."

CONDITION AND TONE.

High condition, using the term in the sense of over fatness, predisposes to lung congestions, as seen in fat pigs and cattle when over-driven, and

to that derangement of the digestive organs so commonly occurring in stall-fattened oxen. Absence of tone, by which is meant a lack of vigour, and flabbiness, of the heart and muscular system together with feebleness of digestion and assimilation, may be set down as predisposing to congestions and dropsies, and anæmia, and want of what is known as "physiological resistance," and is often responsible for determining an attack of contagious or infectious disease.

HABIT.

Instances of "habit" in animals predisposing to, or inducing, disease, are by no means so common as is generally supposed. The erroneously termed "bone chewing habit," so usual amongst cattle in certain districts and certain seasons, is evidence of a depraved appetite—an effect of disease rather than a cause; and in the same category may be included the "wind-sucking," "crib-biting," "weaving," and "stamping" habits of stabled horses. Amongst racing entires, the habit of spurious seminal ejaculation or self-abuse results in decline of their racing powers and general physical vigour, but beyond an abnormal lassitude and lethargy, it is not usual for actual diseases to be induced. The habit of licking themselves is responsible for the formation of hair balls in the stomachs of cattle; and in horses the injury resulting in capped elbow is often attributable to the awkward position in which the animal habitually lies.

EXERCISE.

It is the want of exercise rather than its excess that predisposes to disease attacks. Excessive exercise acts as an exciting cause. Such diseases as lymphangitis (weed or shot of grease), azoturea, congestion, and inflammation of the lungs and laminitis (founder) are likely to occur after a long period of abstention from exercise has been suddenly terminated.

NATURE OF WORK.

The activities of the animal, and the direction in which its energies are expended, have considerable influence on the occurrence of disease. Broadly speaking, it may be said that the greater the amount of functional activity in a part the greater the liability to disease. One of the best illustrations of this statement is afforded by the modern dairy cow, which has had the milking capacity developed to an extraordinary degree with the result that the udder is now-a-days the frequent seat of many diseases of an inflammatory nature which, prior to the inordinate increase of its lacteal activities, were comparatively rare.

The "'ammer, 'ammer, 'ammer on the 'ard 'ighway" is notoriously responsible for the occurrence of laminitis, or founder of the feet, and of splints in roadsters, and sidebones in draught horses. Sprains generally—in the racehorse sprains of the superior and inferior suspensory ligaments and back (flexor) tendons, and curbs, and in the draught horse sprain of the inferior check ligament below the knee—are predisposed to by the great strain liable to be imposed on the parts by the strenuous exertion during a race in the one case or a heavy up-hill pull in the

other. Hunters are particularly prone to congestion of the lungs and spasm of the diaphragm, on account of their being frequently subject to conditions inducing distress; and as an instance of the nature of the work predisposing to accident, the dislocations of the toe bones which are of frequent happening in coursing dogs may be cited.

Exciting Causes of Disease.

As previously indicated, it is intended to consider under this head as exciting causes of disease *per se*, only such agencies as between which and the disease produced there is direct evidence of cause and effect relationship. Such agencies may be broadly classified as *vital* (microbes and parasites), *physiological* (medicinal agents and poisons), *mechanical* (violence), and *chemical* (poisons and toxins).

VITAL EXCITING CAUSES.

Living germs, or micro-organisms, or microbes, are now known to be the exciting cause of many diseases which, without their presence, cannot occur. When the subject of microbic disease is being dealt with in its special place, the mode of operation of germs in the production of many diseases will be indicated, and it will suffice here to say that it is extremely probable that all contagious, infectious, and transmissible diseases are caused by germs, although, as yet, the actual demonstration that such is the case in regard to some of the diseases which most markedly belong to one or other of these classes, is not possible. Foot and mouth disease, rinderpest, cow-pox, sheep-pox, rabies, and epizootic abortion are notable examples of diseases which are essentially communicable, but of which the actual causative germs have not, up to the present, been discovered. Until recently, pleuro-pneumonia of cattle, distemper of dogs, pneumonia and strangles of horses could be placed in the same category, the casual organisms having been demonstrated only within the last year or two. On the other hand, the microbic origin of anthrax, blackleg (symptomatic anthrax), tuberculosis, lockjaw (tetanus), glanders, and swine fever respectively, has been beyond dispute for a number of years.

There are one or two diseases of which milk fever, azoturea, and rheumatism are perhaps the most prominent examples, about which our knowledge, though not at all limited, is so uncertain that there is scarcely justification at present for classing them as germ diseases.

Parasites, both external and internal, are disease-causing vital agencies, which are essentially direct or exciting. Lice in itch or pruritis, the *dermatodectes* and *symbiotes* parasites in mange and the tinea fungus in ringworm are ecto-parasites whose disease-producing action can be readily observed. The "sturdy" parasite (*cœnuris cerebralis*) in the brain of sheep, causing "gid" or "staggers"; the fluke parasite (*distomum hepaticum*) in the liver of sheep and young cattle, causing diarrhœa and emaciation; the lung worm (*strongylus filaria*) in the bronchial tubes of lambs and calves, causing bronchitis; tapeworms (*tænia cœnurus*) in the intestines of dogs, causing diarrhœa and indigestion; and hydatid cysts throughout the organs of various animals may be instanced as types of internal or endo-parasites which excite disease.

PHYSIOLOGICAL EXCITING CAUSES.

Closely allied to vital or living exciting causes of disease are those which excite or depress the various physiological functions of the body. Amongst such causes may be included the actions of medicinal agents in inducing what may be termed artificial disease—purgatives setting up diarrhœa, astringents inducing constipation, vesicants (blisters) causing congestion and inflammation, stimulants producing delirium, narcotics effecting coma (unconsciousness), and so on. Some poisons act physiologically—prussic acid, strychnine, opium, aconite, alcohol, and many other poisons produce their lethal effects by stimulating beyond endurance or depressing beyond recovery the physiological activities of nerve tissue. Snake poisoning in its most ordinary manifestation is a striking example of death being produced by physiological depression.

MECHANICAL EXCITING CAUSES.

Violence, when directly exerted, causes fractures, sprains, bruises, abrasions, wounds, and other injuries. Indirect violence, such as occurs from concussion during fast work on hard roads excites splints, spavin, sidebones, ringbones, and laminitis.

Foreign bodies may mechanically obstruct orifices and tubes, and so cause disease, as, for example, in choking, in constipation, and impaction from intestinal calculi, in uræmic poisoning from blocking of the urinary passages with gravel or stone, in gangrene of the lungs and other organs from blocking of the blood vessels by means of blood clots formed *in situ* (thrombi), or particles of blood clot, tissue or pus conveyed from a distance (emboli).

Pressure.—Tumours pressing on the brain, and cysts and inflammatory exudates pressing on the spinal cord or nerve trunks, causing epilepsy and paralysis; liver abscess occluding, by compression, the biliary duct, and causing jaundice; and the undue bearing of the shoe on the angles of the heels, causing corns in horses, are all examples illustrating pressure as a mechanical cause of disease.

CHEMICAL EXCITING CAUSES.

Many poisons produce their effects by chemical action on the tissues. For example, the mineral acids, caustic alkalies, arsenic, tartar emetic, nitrate of silver (lunar caustic), and other caustics; also astringents such as tannin, catechu, and sulphate of copper (bluestone).

Certain waste matters from the body produced as a result of tissue change, which are excreted by the lungs, liver, kidneys, and skin under normal circumstances, commonly exert their deleterious effects chemically (when retained in the system from any cause). Thus, retention of urea produces azoturea and uræmic poisoning; retention of bile gives rise to jaundice; and when carbonic acid gas is not eliminated, unconsciousness and delirium result.

The various toxins which are produced by the action of living germs during the progress of such diseases as anthrax, septicæmia, and tetanus, are also presumed to act chemically; and it is by the elaboration and action of these toxins, rather than to the other activities of the germs, that the evil effects of germ diseases are due.

SOIL BACTERIA.

A. A. Brown, M.B., B.S.

No. 4.

Fixation of Nitrogen by Nitrifying Bacteria and by Chemical Processes.

In article No. 3, which appeared in the *Journal* for November, 1905, it was stated that means existed by which plants could avail themselves of the free nitrogen present in the atmosphere, and transform it into compounds suitable for plant food, and in this article we will commence a discussion on the many facts associated with this profound problem; and we will endeavour to furnish, along with other appropriate information, a general idea of the intricate workings of bacteria in the soil. It may at once be stated that it is now definitely known that certain plants, by a wonderful property with which they are endowed, can make use of the free nitrogen of the atmosphere as a food. This wonderful property of taking hold of free nitrogen and elaborating it into nitrogenous compounds is inherent in leguminous plants, and, in the present state of knowledge, leguminous plants are not to be regarded as by any means the least in importance amongst all the important factors in the realm of vital forces.

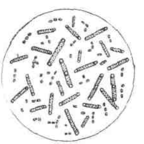
It had long agitated scientific minds as to whether atmospheric nitrogen could be utilized directly by plants as food. For a long time the balance of opinion was against the idea, and it is easy enough nowadays to comprehend the great difficulties that beset the paths of early investigators who tried to solve the profound problem. Berthelôt, in 1876, first definitely proved that some plants had the power of fixing free nitrogen, and he also maintained that some *soils*, apart altogether from plant life, had the power of taking up nitrogen and converting it into nitrates. This property, we now know, is possessed by certain bacteria which reside in the soil, and which are capable of exciting *nitrification.*

In the soil, under natural conditions, *nitrifying* bacteria are perpetually at work and constantly adding nitrates to it. If a soil is allowed *rest*, its quantity of nitrates will be spontaneously increased, so *rest* and *fallow* are factors in increasing the amount of nitrates in the soil. The nitrogen for the production of these nitrates is, in part, derived from the atmosphere, and certain bacteria in the soil have the power of seizing hold of free nitrogen and of converting it into nitrogen compounds, which eventually are transformed into nitrates. Nitrogen, then, can be combined in the soil by certain bacteria without the intervention of plant life; but, although this power of fixing free nitrogen is not distributed over a wide range of germs, nevertheless its importance in Nature must not be under-estimated. It probably is of far greater moment than we at the present day can ever hope to form a proper appreciation of.

The passage of a flash of lightning through the air causes a combination of the oxygen and nitrogen present therein, and the nitrates thus formed are ultimately washed into the soil by the rains. Then, again, by the agency of electricity, nitrogen can be fixed, and it is possible that the near

future may see great developments in the direction of the production of artificial nitrates for manurial purposes by the use of this force. Nitrogen from the air can also be fixed by being compelled to pass over carbide of calcium at a high temperature, and this process of *fixing* nitrogen can be conducted on a scale to produce nitrates at a reasonable cost, and in large quantities.

I have cultivated from the soil of Melbourne a bacterium identical, morphologically, with the bacillus ellenbachiensis, an organism said to



BACILLUS ELLENBACHIENSIS FROM SOIL OF MELBOURNE (HIGHLY MAGNIFIED).

have the power of *fixing* free nitrogen under certain circumstances. It is however, quite probable that all soils contain bacteria that can *fix* free nitrogen in an insoluble form, and, to obtain the maximum effect from them, all that is needed is proper cultivation and treatment of the land. Professor Eschweiler, of Hanover, and Dr. Woltereck, of London and New York, claim to have discovered a new process of *collecting* and *fixing* free nitrogen from the atmosphere, not directly through the roots of plants, but by taking advantage of changes associated with the combustion of peat. The process consists in passing a current of air mixed with steam over a mass of peat maintained in a state of slow combustion. As a result, ammonia is formed by the chemical combination of hydrogen obtained from the steam, with part of the nitrogen originally present in the peat and part of the nitrogen contained in the air passing over it. Then the current of mixed gases is passed through sulphuric acid, and sulphate of ammonia is formed. It is said that five tons of ammonium sulphate can be obtained from 100 tons of peat. As time goes on, yet more effective and simpler artificial processes may be alighted on for combining the free nitrogen of the atmosphere in a form suitable for plant food.

If large quantities of nitrogen can be fixed by any or all of the various methods to which attention has been drawn, then no alarm need be felt as to the source from which future supplies of nitrates will be obtained to meet the world's requirements.

FIXATION OF NITROGEN BY LEGUMINOUS PLANTS.

There are certain plants (*leguminous plants*) working in conjunction with certain bacteria (*nitrogen-fixing bacteria*) that have the power of seizing hold of the free nitrogen of the atmosphere and of combining it in their tissues, and thus increasing the amount of combined nitrogen in the soil. We have already pointed out that plants can obtain the carbon they require for their nourishment from the carbonic acid gas of the

atmosphere, and, at first glance, it might appear that plants might also be able to obtain their nitrogen from the free supply of this gas in the atmosphere in much the same simple fashion but careful experiments, however, have conclusively shown that the general run of plants cannot obtain their nitrogen in any way analogous to the way in which they obtain their carbon. There is, however, one order of plants—the *Leguminosæ*—that is definitely known to possess the power of absorbing the free nitrogen of the atmosphere in a remarkable fashion. If we pulled up, in its entirety, one of these leguminous plants, and examined its roots, we should find them covered with little lumps, or nodules. These nodules are easily seen on the roots, and, when examined microscopically, they are found to be full of bacteria. These bacteria have the power of taking hold of free nitrogen, and of *fixing* it in the nodules. For convenience, these bacteria are called nitrogen-fixing bacteria. With but few exceptions, no other plants, except leguminous plants, have the property of being able to obtain their nitrogen direct from the air. All other plants, without exceptions, can only avail themselves of nitrogen as a food when it exists in the form of nitrate.

All leguminous plants, by the agency of the nitrogen-fixing bacteria, are able to assimilate free nitrogen, and manufacture it into nitrogenous or proteid material, just as all classes of plants are able to obtain carbon from the carbonic acid gas of the atmosphere, and build it up into highly complex organic compounds. The discovery of these organisms in the tubercles on the rootlets of leguminous plants was made by Hellriegel and Wilfarth. The absolute necessity for the presence of these organisms in the soil intended to grow leguminous crops was shown by Nobbe. He sterilized soil, containing all necessary plant food constituents, by heating it to a high temperature, and then he planted in it seeds of legumes. Sterile water was used to water the plants. The seeds germinated, the plants appeared above ground, but were stunted, and remained stunted throughout their period of growth. On examining the rootlets of these plants no nodules were found. In other portions of the same soil, which were not sterilized, control plants showed a luxuriant growth, with abundant formation of tubercles.

Again, seeds of a leguminous plant sown in ordinary soil, containing all necessary plant foods, except nitrogen, and watered with pure water, will exhibit marked peculiarities. The seeds will germinate just as if a store of nitrogenous foods existed in the soil, and, at the outset of existence, the young plant develops just as well in the absence of nitrogen from the soil as in its presence. It feeds at first upon the foods stored up in the cotyledons, or seed-leaves. As soon, however, as this store of food is exhausted, the plant receives a temporary set-back to its development, and, judging by the appearance it assumes, one would think that it was about to perish, and that it could not again recover its vitality. The cause of the sickly condition is to be attributed to the absence of nitrogen, for all other foods are present. The condition is one of *nitrogen-hunger*. Any plant—apart from a few exceptions, to be mentioned later—but a legume, if grown under conditions such as those detailed, would never recover from this condition of *nitrogen-hunger*. A legume, however, will be observed to remain sickly from a few days to three weeks, according to circumstances, and will then quickly recover. It will rapidly become green, and start to grow vigorously. When mature, it may be just as

large, and contain just as much nitrogen, and possess as many tubercles, as one provided with a nitrogen fertilizer from the start. These experiments demonstrate that leguminous plants can grow in a soil destitute of nitrogen; but it must not be concluded that it is not necessary for a soil to possess nitrates to promote the growth of leguminous crops. On the contrary, the presence of nitrates assists the leguminous crops to tide over the *nitrogen-hunger* stage; but, as soon as that stage is passed, they no longer require nitrogenous manures, for they then can readily procure all the nitrogen they require from the atmosphere. In practice, the fact is taken advantage of by farmers, who plant soils poor in nitrogen with leguminous crops. When the crops are mature they are ploughed into the ground. The ploughing in by the farmer of green crops constitutes the practice known as *green-manuring*, and reference will be made to it later.

It is highly probable that the original sources of the world's stock of combined nitrogen that is now being exploited are to be traced to the activity of the bacteria found in the nodules of leguminous plants.

ROOT-TUBERCLES OR NODULES.

On examining a leguminous plant that is carefully pulled up from the ground in its entirety, there is observed on its roots and rootlets a number of little tubercles, or nodules, or swellings. Their size varies much, and varies also according to the variety of plant examined. Some may be as small as a pin's head, others as large as a pea. These nodules had for centuries attracted attention, and were long thought to be of the nature of a disease. It was, however, a puzzle to observers to find that those plants that had the most nodules were the most vigorous, and those that did not, for some reason or other, develop tubercles, or that only developed them in moderate amount, were poor in comparison with those that had them largely developed. This fact, no doubt, to them, exploded the notion of their being a disease, but their function was not then understood.

A series of experiments in connexion with their formation led to very interesting results being obtained. It was found that tubercles would not form if the plants were grown in sterilized soil and watered with sterilized water. Killing the bacteria in the soil had a profound influence on the development of the plant, and, indeed, unless sufficient nitrogenous food was added to meet the plant's requirements, it would perish. In sterile soil, even when nitrogenous food is added in sufficient amount, plants do not vigorously thrive. They are stunted in their growth, and form no nodules. Now, leguminous plants grown in sterile soil quite destitute of nitrogenous food, but watered by water with which ordinary soil has been mixed, but from which all solid particles have been filtered, display peculiar characteristics. Legumes grown in sterile soil containing no nitrogenous material, but watered with infusions of ordinary soil, from which all solid matters have been removed, eventually become vigorous plants, but a marked peculiarity in the course of their growth is observed. The seeds, when sown in such soil, readily sprout, and the little plants grow splendidly until all the nitrogen stored up in them is exhausted, and then they become sickly. The leaves turn yellow, and show an appearance of drying up. This sickly condition is caused by lack of nitrogen, and Cohn speaks of this stage in the development of the plant as the *nitrogen-hunger*

stage. After enduring nitrogen-hunger for a few days, the plants recover their vitality, become green again, and start growing vigorously, and, when mature, are large-sized plants, yielding good crops.

Now, control plants, grown in sterile soil, destitute of nitrogenous material, and watered with pure water, sprouted just as readily as those watered with soil infusions; but, when all the nitrogen in the seeds was used up they became sickly, and from this condition they never recovered, but died away.

It has already been stated that, upon examining the roots of those plants that were grown in sterile soil which was watered with soil infusions, numerous nodules were found; whereas on the roots of plants grown in sterile soil, containing all necessary plant food constituents, but watered with pure water, no nodules were found on the roots. The facts detailed indicate that in the soil infusion there was an agent which favoured the development of tubercles, and thus led to the fixation of nitrogen with vigorous development of the plant. Leguminous plants possess the property of being able to fix nitrogen in their tissues, and it is this property which is inherent in them that enables them to tide over the *nitrogen-hunger* stage. The bacteria that exist in the nodules can in some way transform the free nitrogen into nitrogenous material, and thus lead to the plant being supplied with this indispensable food.

ROOT-TUBERCLE BACTERIA.

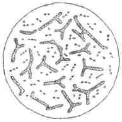
The facts that have been detailed concerning the production of tubercles led observers to assume that living organisms were the agents effecting the processes. Microscopic examination of the tubercles led to the discovery in them of small bodies of various shapes and sizes, but early investigators thought that these bodies produced a disease of the plant tissues, thus causing the development of the nodules. Nowadays their function has been determined, and, instead of being regarded as of a baneful nature, they are incorporated amongst the propitious organisms on the globe. Bacteriologists, after the discovery of the germs in the nodules, set about isolating them and growing them in special culture media. By adopting certain laboratory methods, the bacteria can be isolated and grown pure. In gelatine-plate cultures, they form small mucinous colonies, but do not liquefy gelatine. They are strictly aerobic, and demand full supplies of oxygen to promote growth.

That the bacteria produce the tubercles seen on the rootlets has been definitely proved by experiments. As already related, leguminous plants were grown in sterile soil, possessing no nitrogenous material, but watered with soil infusions that naturally contained the organisms, with the result that numerous tubercles formed on the roots, and the plants developed; whereas plants grown in similar soil, but watered with pure water, developed no tubercles, and perished.

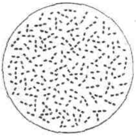
In germinating peas, kept moist and warm without being planted in the soil, nodules can be made to appear on the rootlets, if such are wounded by being pricked with a needle, and then dipped into mineral solutions containing pure cultures of the germs.

In the nodules the bacteria may display many grotesque forms. Some are γ, and some τ shaped, some are branched, some are like the Greek λ, some are rods, and some are cocci. Sometimes long thread-like masses filled with bacteria are seen. A drawing by the Government Printer of

the germs found in the nodules of the broad-bean plant shows various forms, and some indication of their appearance can be obtained from the preparation, which was made in my laboratory. A drawing of the bacteria, derived from the nodule of the broad-bean plant, but cultivated in specially-prepared gelatine before being mounted, reveals an almost uniform type of organism, thus offering a contrast to the form of the germ as it exists naturally in the nodules.



BACTERIA FOUND IN NODULES OF BROAD-BEAN PLANT (HIGHLY MAGNIFIED).



BACTERIA CULTIVATED IN GELATINE FROM NODULES OF BROAD-BEAN PLANT (HIGHLY MAGNIFIED).

The nodule bacteria, no doubt, exist in almost all soils, and make their way into the roots through the delicate root-hairs at a very early stage of the plant's growth. Once inside the roots, they find favorable conditions for development, and they, no doubt, stimulate the tissues, so that an increased growth of the roots occurs. The tubercles are really growths produced by the activity of the germs, and, although it may be quite easy to demonstrate that the germs produce the tubercles, it is not so easy to show that they can cause the plants to assimilate free nitrogen from the atmosphere. It is not definitely known whether the nitrogen is absorbed through the leaves or through the roots, but the balance of opinion inclines to the assumption that it is absorbed in the soil water through the roots. The nitrogen, then, does not directly come from the air, but from nitrogen dissolved in the soil water, the ultimate source of which, however, is the atmosphere. Leguminous plants are an essential factor in the *fixation* of nitrogen, but the plants cannot *fix* the nitrogen in the absence of the bacteria, nor can the bacteria vigorously thrive in the absence of the plant. The association of the leguminous plant with the nitrogen-fixing bacteria, *Bacillus radicicola*, is the condition essential for the *fixation* of nitrogen. The association of two different organisms working together for mutual benefit is known under the name of *symbiosis*. Whether it is the plant or the bacillus that fixes the nitrogen, or whether the two must work concurrently to produce the result, is not clear. Some investigators claim that the bacillus fixes the nitrogen, and that the roots are simply appropriate media for their development. This is quite possible, for, as already pointed out, certain bacteria can fix free nitrogen independently of leguminous plants, so that it is possible, indeed, that the bacillus can fix free nitrogen independently of leguminous crops, and, if that circumstance should prove to be trustworthy, then cereal crops might be benefited by an application of cultures of the germs to the soil. In a plot on which I carried out experiments, a maize crop, and subsequently an oat crop, appeared to have benefited materially by the application to the soil of pure cultures of nitrogen-fixing bacteria derived from the pea, broad bean, and clover. The control plots, to which no germs

were added, did not show such vigorous growth, but extended experiments will require to be made before definite announcements can be made, and it is only by experimentation that trustworthy results can be obtained.

Again, some investigators think that the leguminous plants fix the nitrogen through the agency of their leaves and roots, the germs in the roots merely serving as agents to stimulate the normal functions of the plants. Those who maintain this view declare that many other plants besides the legumes can fix small amounts of nitrogen. They say that algæ, oats, mustard, and other plants can assimilate free nitrogen. Even if such plants can *fix* nitrogen, the quantity they assimilate is extremely small as compared with that fixed by legumes. Ordinary plants, or even leguminous plants, in the absence of bacteria, have but little power in *fixing* a quantity of nitrogen appreciable to the chemist. It has been remarked that certain soil bacteria can *fix* free nitrogen in an insoluble form, and it has been suggested that tubercle bacteria avail themselves of these compounds and render them soluble for the needs of leguminous plants. It is impossible to say which theory is correct, but the fact that the *Bacillus radicicola* and the leguminous plant working together can *fix*, in large amounts, free nitrogen is indubitable. Under natural conditions, the bacteria in the nodules, along with the protoplasm of the nodules themselves, are incessantly joining forces with the nitrogen circulating in the soil to promote its conversion into organic material. It must not be overlooked that, although leguminous plants can, in the presence of the bacteria, fix free nitrogen even in the absence of nitrogenous compounds, yet they prefer taking their nitrogen from nitrogen compounds in the soil, if such compounds exist in sufficient quantity. If, however, the soil does not furnish them with sufficient combined nitrogen for their growth, then they fall back upon the atmosphere for their supplies. If a soil is well supplied with nitrogenous material, there is little or no *fixation* of free nitrogen by leguminous crops; but, if the soil is poor in nitrogen compounds, then the leguminous crops draw upon the atmosphere for the nitrogen food they require. The *fixation* of nitrogen by leguminous plants and nodule bacteria working in unison occurs only when the soil is deficient in nitrogenous plant foods, and, where such deficiency exists, legumes and bacteria, conjointly acting, restore its fertility.

(*To be continued.*)

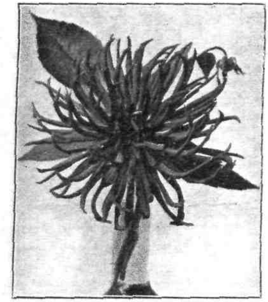
GARDEN NOTES.

J. Cronin, Inspector Vegetation Diseases Acts.

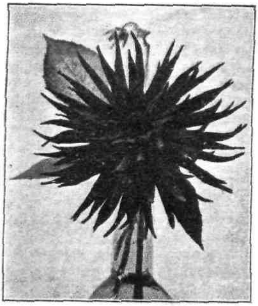
The Dahlia.

The Dahlia is a hardy, herbaceous, tuberous-rooting, perennial plant; the whole of the original species being natives of the sandy meadows of Mexico. The dahlia was first introduced into Spain and England in 1789. The original plants imported into England were lost, but seeds were introduced five years later, from which plants were raised and

cultivated. The credit of improving the original types, the flowers of which were single or semi-double, is due to Continental gardeners, who, during the period of the Napoleonic wars, had raised many varieties of superior character. Count Leliur, of St. Cloud, in France, was one of the most successful hybridists, raising a number of fine double-flowered varieties of varying shades of colour. After the peace of 1815, the finest Continental varieties were introduced into England, and gardeners there began the work of improvement which has continued to the present. For many years, raisers of new varieties aimed at the production solely of show or fancy dahlias, with rounded petals building into flowers of globular form, and discarded any that varied from that standard. The introduction of a garden variety ("Jaurezii") from Mexico, which produced scarlet flowers resembling certain species of cacti in form, was the beginning of the evolution of the present cactus type. There are still a few gardeners who



CACTUS, "MRS. J. CRONIN." SCARLET, NARROW PETALLED AND INCURVING.



CACTUS, "J. H. JACKSON." MAROON CRIMSON.

aim to raise new varieties of show dahlias, but most of the raisers at the present time attempt to improve the cactus dahlia, the flowers of which are stellate in shape, with long, narrow, rolled petals regularly arranged, and of more or less incurved form. The original cactus type is altogether superseded, and so are many of the finest varieties known five years ago. A number of these are now classified as decorative dahlias, the petals being broader than in the later types. Other classes are Bedding and le. ompon dahlias, really branching and diminutive show kinds, and the epenle varieties. The tree dahlia (*Dahlia imperialis*) is grown occasionally, bacil arely blooms where early frosts occur.

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PROPAGATION.

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CUTTINGS—DIVISIONS—SEEDS.

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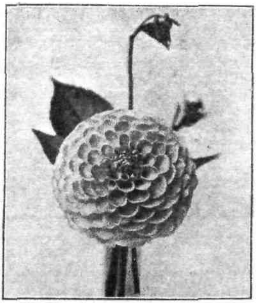
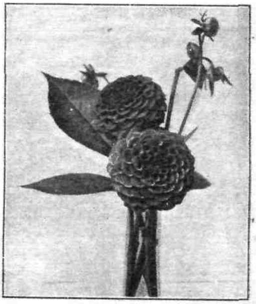
on to the of the plants purchased from nurserymen are produced from pea, broad en from plants that have been forced into growth in hot-houses

during September and October. The cuttings are taken from the plants when about 3 inches long, and inserted in small pots filled with sandy soil. The pots are placed on a heated tank, where the cuttings root in two or three weeks, afterwards being re-potted and gradually hardened preparatory to being planted out in season. Division of the crowns is usually the method employed by gardeners who have no hot-house. The roots are divided from the stems downwards, care being taken that there is a growth bud on each division. There is no need to divide the crowns until the buds are well developed. One tuber with a portion of the stem, carrying one or two buds, is sufficient, but tubers only are useless. Seed should be sown in the open ground, or in pans or boxes, early in October. Light soil is most suitable. If slugs or snails are prevalent, they will destroy the young plants, unless prevented. The plants should be shifted to their flowering quarters when about 3 inches high. Fair room should



A TYPICAL SHOW VARIETY, "MRS. OCOCK."



POMPON, "ISABEL."

be allowed them, for they will grow into large plants during the season, and will bloom during March and April.

SOIL AND CULTURE.

Dahlias thrive best in a soil fairly friable and rich in plant food. Some of the finest exhibition blooms shown in Melbourne are grown in light sandy soils. Strong, fairly open, loams will produce equally fine blooms, often more correct in type. Good drainage is an absolute necessity. The beds should be prepared some months before planting time. A good dressing of cow or stable manure (or a mixture of each), half rotted, should be worked deeply into the soil, and occasionally turned over. In the last digging before planting, a dressing of bonedust or superphosphate should be worked into the beds. When choosing a site for a dahlia bed, a position sheltered from the heavy winds should be selected. Exclusion of light and sunshine by high buildings will "draw" and

weaken the plants; planting near large trees will have a similar effect An easterly aspect, with comparatively low shelter from wind, is best.

Dahlias are at their best during March and April, and to have them in bloom at that time, plants should be set out late in December and early in January. Divisions of crowns may be set out a fortnight later than young plants grown in pots. A stake should be driven firmly into the soil before planting, and the plants lightly shaded for a few days, should the weather be hot. After culture will be occasionally stirring the surface, tying as growth advances, thinning shoots where crowded, and watering. A mulch of stable manure should be applied at beginning of February, and will save a deal of watering and keep roots cool and moist; they must be maintained in this state in most soils, or red spider will attack and spoil the plants.

If exhibition blooms are desired, about six or eight shoots only should be allowed to grow, and from these the lateral shoots should be removed as they develop. The flower-buds should also be thinned, but not too severely, or coarseness will follow. After the plants "die down" they may be lifted and stored in a cool dry place, or may be allowed to remain in the ground till the end of winter, and then be lifted and stored until planting time. The cactus section is most popular, and the following are good up-to-date varieties:—"Florence M. Stredwick," "Fairy," "Mont Blanc," "Mrs. F. McQuade," "Mabel Kerslake," white; "Mrs. E. Mawley," "H. F. Robertson," "Sunflower," "J. P. Barber," yellow; "Premier," "Conrad," "Mrs. J. Cronin," "Vivid," "Oliver Twist," red; "Mrs. J. W. Wilkinson," "Mrs. Adrian Knox," "Pink Pearl," pink; "J. W. Wilkinson," "J. Weir Fife," "Sir A. Lamb," "Purple Jackson," purple; "Charm," "Cockatoo," parti-coloured; "Mrs. T. Rooney," "J. B. Riding," "J. H. Jackson," "Mrs. G. H. Kerslake," "Germania," other shades and colours.

Flower Garden.

As the herbaceous plants finish blooming the stems should be cut to the ground, and in case of such as chrysanthemums the stools removed to some out-of-way place during the winter. The removal facilitates manuring and digging the beds especially, and the young plants will be hardier and sturdier when wanted in spring. A good dressing of fresh soil will be of more value than manure, especially in small gardens where particular plants are grown in the same beds each year. A few inches of the "top spit" of ordinary pasture land of the nature the plants require, with manure worked in with it, will make the garden staple almost equal to virgin soil. Too much stable manure is often added to the soil in small places, the consequence being that the soil becomes cold and sour. A dressing of fresh lime and some new soil will be of great benefit in such cases.

Beds for the reception of roses should be prepared, clay being added to light sandy soils. Well-rotted manure should be used, and worked deeply into the beds. Nothing is gained by very early planting of roses; next month will be quite early enough. A list of the best new kinds will be supplied in the June issue.

Hardy annuals may be planted, as also a number of bulbous plants, including Tigridia, Lilium, Iris, Tuberose, Lily of the Valley, summer-blooming Amaryllis, and many others.

Kitchen Garden.

Ground that has been occupied by tomatoes, beans, &c., should be got ready for planting onions, cabbage, &c., later on. When preparing land for carrots, beet, and other root crops, it should be deeply worked and liberally manured at the bottom of the trench. A rich surface, with a hard and poor bottom, encourages forking in such vegetables, instead of long straight roots. Seeds of early peas, onions, and various saladings, may be sown.

PROFITABLE POULTRY FARMING.

H. V. Hawkins, Poultry Expert and Lecturer.

Readers of the *Journal* will remember my articles on Poultry Breeding and Management in last May's issue. Those who followed the advice contained therein should now have a goodly stock of cockerels and pullets. The former may be troublesome, and doubtless you are pondering in your mind what to do with them. If of a pure breed, such as Leghorns, Wyandottes, Orpingtons, &c., select, say, two or three of the best, put them aside, and take special care of them as you will require a vigorous, typical specimen next month in your breeding pen. See that the selected few are of robust constitution, fair size, not too leggy, with bright eyes standing well out of the sockets, the comb erect and firm at base, and not too large, the serrations nice and even, no side sprigs.

After selecting what, to your mind, are the best, dispose of all surplus cockerels, according to quality, size, &c. Your neighbour may be glad to purchase one to improve his stock—pure-bred birds, well matured, are worth at least 7s. 6d. each. Having sold all you wish to, place the others in a separate yard by themselves, and prepare them for market; the sooner you get them off your hands the better. Fatten as quickly as possible, giving them a mixture of 1 part pollard, 1 part barley meal (and with it occasionally a little rice flour), and 1 part bran; add to this a little chopped raw beef suet, and boiled liver, using the liquid from the latter to mix the meal, which must be crumbly, not sticky. Give as much as the birds will eat readily, your object being to force on flesh. At midday, green food should be given, such as lucerne, lettuce, beet, or onions, chopped up. The birds relish this, and it keeps up condition. Have no fear of theorists who remark that onions will taint the flesh—you are only adding to the meal, not feeding wholly on any one particular food.

For the evening meal, give a handful of crushed maize and occasionally scalded barley or oats. It is astonishing how birds in confinement relish maize; it is easy to digest, but too much will darken the flesh (it is also too fattening for laying hens). My object is to show how to put on flesh and to have it white.

When skim milk is available, give your birds plenty, as it is rich in flesh formers. It also whitens and gives succulence to the meat

PULLETS.

Pullets that since hatching time have been wandering and picking up most of their living by insects, &c., should now be penned up and fed as

directed by me in the *Journal* already referred to. If allowed full libert and by constantly being on the wet grass and picking same, the develop ment of the ovarium egg cluster is retarded.

TOP PRICES FOR EARLY EGGS.

You are anxious to get eggs, and now is the time to secure good payable prices. This will mean more care and proper feeding, but will amply repay the additional labour it involves. The main reason for the scarcity of eggs from early hatched pullets is mainly due to too much wet grass, which results in much food being wasted by passing through the system too rapidly owing to the excess of water taken in with the grass.

PENS PAY BEST.

Penning up the early pullets with but little grass in the runs is a sure means of bringing them on to lay. We have only to ask ourselves the question, why do the pullets at Dookie and Hawkesbury Agricultural College competitions lay so well and pay such handsome profits?—It is because they have only a certain amount of liberty and are not kept in huge numbers—six in a pen—and those six fed on a ration which allows of more protein than is required in keeping up the repair of tissue, the balance goes to produce eggs.

I am informed that eight at least of the pens at the last competition laid on an average over 200 eggs each bird. This is surely conclusive evidence that by care and mating up the breeding pens, poultry breeding for egg production pays well. During my visit to South Gippsland, while lecturing at the farmers' classes at Leongatha, I was invited to visit a student who had eleven months ago purchased a copy of the May Poultry number, and who set to work to follow out the instructions laid down, having had no previous experience. He built his pens with great accuracy. It is the Director's desire that the students shall imitate the teaching of each of the experts engaged in lecturing. However, I must not diverge from my subject. My friend, in following the sound principles laid down, has netted over £35 in less than twelve months, and now has quite a large asset in his flock of pullets. It is recognised that the South Gippsland district is a cold, bleak, wet one, and complaints are legion that the hotelkeeper and the housewife cannot get eggs in autumn and winter in this district, yet we have here an example of one who has made ample provision for drainage, shelter, dry, sound houses, and by proper feeding, has received an average of 11d. per dozen for his eggs. My conviction is that highly satisfactory results can be obtained in the coldest parts of Gippsland if cheap barns made of saplings and bark (obtained for the asking), 40 x 15 feet or larger if required, facing the north-east, well ventilated, and dry are utilized. Add to the ground floor a good load of hay, or dry litter, with ample supplies of grit, charcoal, coarse sand, oyster shells, burnt bones, and dust boxes. Give fresh water daily, and pay special attention to green food at midday. The morning meal, for the birds confined thus, should contain 1 ounce of animal food with at least 1½ ounces pollard and bran, mixed with boiling water, and given each morning at daylight, and grain, consisting of a mixed diet—1 part wheat, 1 short oats, and 1 maize—at night, a handful to each bird.

Twenty-five white Leghorns, black Orpingtons, silver or white Wyandottes, or silver Dorkings will lay all through the coldest weather. I have tested this myself, and have found the result excellent. The food should never be given to birds in troughs or on sacks, but scattered amongst the litter, enabling the birds to exercise themselves by scratching about for the food.

Who in the southern parts of cold Gippsland will have enterprise enough to test this?—Some may say, what about vermin?—There is little to fear in that respect, as vermin breed in October, November, December, January, February, and March, when eggs are cheap. It is only during the autumn and winter months that you will require to house the birds, and no fear of insect pests need trouble you, and your eggs will bring from 1s. 4d. to 2s. 4d. per dozen. Be on your guard against the three W's—too much Wind, too much Water, and too much Wheat.

PROPER BREEDING SEASON.

"When does the breeding season commence, and when does it cease?" are questions often asked, but too often overlooked. Many make the serious mistake of setting eggs in November and December, thinking they have not yet enough chicks out. Let me strongly advise such to be satisfied with a few early birds, than run the risk of losing the lot, through overcrowding, with late chickens. The birds of the air, from the sparrow to the nightingale, have their proper season. I ask, does it seem reasonable to expect a pen of birds, each of which may lay 175 eggs per year, to produce a similar number of chicks?—Decidedly not.

If you are going in for large flocks of birds, you must, of course, have more than one breeding pen. Do not overtax the stud flock. Carefully gather the eggs, and when each hen has laid her fifth egg, and not till then, commence to reserve for the incubator. Then each egg that is laid, up to about 40, should produce the strong embryo germ, that, when hatched, has stamina, frame, and good bone. It is more easily reared and matures twice as rapidly as those from eggs out of season, *i.e.*, November, December, and January, and is a sure layer when eggs are scarce. Such pullets hatched in August or September, or as early as July in the northern districts, will pay over 100 per cent. profit in a season.

I am anxious to show the farmer or his wife that the old idea of setting hens, when they are inclined, is out of date. We are living in days of improved methods—the result of man's investigation and experimentation. The old broody hen of seven summers is not a success. Artificial methods of incubation have now been brought to perfection, and the farmer may rely upon most of the machines now on the market, but should avoid the second-hand machines. Do not risk failure by beginning in the wrong way. Buy a good make, and even if it costs more, it will amply repay.

The eggs gathered during the months of July and August should then be kept for the incubator, as they will be worth much. (I am, of course, presuming readers have followed my previous articles on the treatment the stud birds should receive.) If your average hatch is only 60 per cent., you have the satisfaction of knowing that the parent birds have been in splendid trim, and not in an impoverished state, the result of being overtaxed, and that the heat of December is not going to worry you, having made up your mind to hatch early and to stop early.

FEED THE MALE BIRD BY HIMSELF.

Feed the male bird well, give him twice as much as the hen, if not, the good results mentioned above may not be yours. To accomplish this will necessitate coaxing him in to a corner by himself. About 1 ounce of hemp seed and animal food (½ ounce of each) mixed daily in the soft food will increase his vigour.

BUY EARLY SEASON EGGS.

Eggs from prize birds are often advertised in the weekly papers in the months of August and September at 21s. per dozen, and from 21s. they are reduced to 7s. 6d. dozen, and possibly are from the same pen of birds.

Buy your eggs for hatching early, do not be misled in purchasing them at the reduced price. Bear in mind that the hen's condition is also reduced, and her egg is smaller and the germ weaker.

This is one of the reasons why folks say poultry will not pay, they having paid 5s. per dozen for eggs from such and such a winning pen, and after watching the broody hen with that care that the amateur usually gives her, seven or eight chicks appear, and the owner is happy for a time. But after three to five weeks a gradual drooping of the chicks' wings is observed, the legs appear very puny, and a hollowness is distinctly visible, showing a bluish colour. All such should be killed off, as they will never pay to feed, all the food in the universe will not give stamina to such. Do not buy eggs when at gift prices, and avoid shop window eggs, unless each egg is guaranteed fresh, and bears the name and address of the breeder, also the date when egg was laid.

COTTAGERS' POULTRY.

Where only a small run is available, keep only one breed, and make it the best by keeping only a few, and that few of a good laying strain. Do not keep more than twelve birds in a yard 30 x 15 feet, and the house scraps will almost be sufficient for their maintenance. Sweep up the manure each day, and there will be no need to fear the municipal inspector. Unclean yards are not only an annoyance to your neighbour, but a menace to the public health. A dozen good fowls will furnish more eggs than the average family requires, and will leave a surplus for pin money. Think what it costs to buy absolutely fresh eggs all the year round!

DEVELOPMENT OF THE COMMONWEALTH.

OVERSEA TRADE OF THE COMMONWEALTH.

	Imports.	Exports.
First Quarter, 1905 ...	£9,523,249 ...	£13,690,619
First Quarter, 1906 ...	£10,772,863 ...	£19,651,702

Of the above totals for the first quarter of 1906, Victoria contributed one third.

THREE YEARS' EXPORTS TO THE UNITED KINGDOM.

	1903. £	1904. £	1905. £	3 Years' Increase.
Victoria ...	4,509,971	7,602,958	8,133,006	80 per cent.
Australia ...	17,057,527	23,568,918	26,968,307	59 per cent.
Canada ...	26,669,855	22,621,164	25,684,679	Nil.

RECORDING DAIRY RETURNS.

R. Crowe, Superintendent of Exports.

"Good morning, Mr. Brown. My word, you have some very fine cows amongst your herd!"

"Well, yes, there are some good cows, a few better than others, but, taking them altogether, I dare say you will not find many better herds in the district."

"What kind of returns do you get from them?"

"There are 67 altogether and my last cheque amounted to £43; not bad for four weeks' supply."

"Yes, that is not too bad, but do you not think it possible to increase the yields? Do you keep any record of the individual returns secured from each cow?"

Mr. Brown smiled and looked at me suspiciously, wondering at my—to him—outlandish suggestion.

I hastened to explain that amongst the most advanced dairymen such a rule was in every day practice, and quoted an instance of one who had eleven cows, and could tell the daily, monthly, and yearly returns of each cow for the last few years.

Mr. Brown remarked that such was possible, no doubt, on the part of a man who had not much to do, and who wanted some means of occupying his time. It was practicable to carry out such a method with a small number of cows, and was probably worth while under such circumstances, but with a large herd it was impracticable, and out of the question.

"It pays, and if it is possible in one instance, it should be in another." I then mentioned a case where a herd of 150 cows was—by a system of recording individual returns—made to double the former average yields in two years by methodical culling and management.

"What would a grocer do if he did not keep accounts? At the end of the month or quarter it would not do to average his customers' bills."

"H'm, I'll think it over."

Knowing from previous experience what the result would be, I decided to remain and see the method started.

"Which of your boys takes the most interest in this branch of the farm operations?"

"Well, Tom, I believe, does. Here, Tom!"

As Tom appeared in considerable doubt, and to resent any additional imposition of duties in connexion with milking operations, I went on to explain, and asked for a sheet of Imperial size paper, that is about 30 inches x 20 inches.

"There is no such paper on the place excepting a newspaper, and I suppose that would not do?"

"Well, a large almanac, or show programme, or, by the way, if you have any brown paper about the house from the draper or grocer's."

A search was made, and from a bundle of various sizes, shapes, and conditions of brown paper, I selected a few sheets, and taking one, asked that the remainder be put aside for future use. With a ruler I quickly ran off 68 vertical spaces and 64 horizontal lines, the highest being 2 inches from the top, then along the top of same the name of each cow was entered, and down the left hand margin the dates were inserted, the sheet

was then tacked on the wall near where the milkers strained the milk into cans. It was a copy of that on this page.

MONTHLY CHART.

For the guidance of Dairymen in recording each Cow's Milk.

NAMES OF COWS.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DATE	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK	LBS. MILK
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TOTAL																								
TESTS 1ST WEEK																								
TESTS 2ND "																								
TESTS 3RD "																								
TESTS 4TH "																								
TESTS AVERAGE																								

Scale—One-third of Practical Size.

On asking for scales none suitable were available, so I told Mr. Brown
m that I would be back again in time for the afternoon milking. In

the meantime I bought a spring scales to weigh up to 56 lbs. for 2s., and suspended same with a piece of wire near the chart. A lead pencil was attached to the wall with a string so that it would be always available.

Milking commenced, and I could see Mr. Brown was somewhat impatient and regarded the arrangement with suspicion, and remarked that the usual time occupied by milking the whole of the cows was just two hours, and with this innovation he doubted whether the cows could be got out of the yard inside three hours. At any rate, he resigned himself to the situation, no doubt thinking that when I was gone the chart would disappear as soon as Tom's interest flagged.

Each bucket was weighed separately, and the weight marked on the handle with a file; three weighed 4 lbs., and the remainder $3\frac{1}{2}$ lbs. each. When the first bucket came along with "Jennie's" milk, the weight of can and milk was found to be 20 lbs., bucket 4 lbs., net weight of milk 16 lbs., date of the month, 7th. "Jennie's" column was found at a glance, and 16 entered on the lower space and opposite 7th. This took some time, as all the other hands stopped milking to watch the proceedings. I told them there was no necessity to do this, as each would have an opportunity of learning when they brought their quota along from each cow. I considered this warning necessary, as much depended on the time taken in doing this new work.

The first weighing in each case was necessarily slow, as a full explanation of the method had to be made to the milker; but before the milking was half through they were all able to find the places and read the weights without any difficulty, but Mr. Brown had in the meantime exhausted his patience and gone off to other duties. Tom, however, was interested, and had taken in hand the supervision of the system. When the cows were turned out, it was found that some ten minutes additional time was occupied. I explained that with a little practice the delay would be less, and in time the method would become part of the milking process. The whole of the milkers gathered round, and anxiously studied the figures; one was engaged in mentally adding the yield of the particular cows he milked for the evening, whilst another was laughing at "Jennie's" downfall. "Jennie," I learnt, was reputed to have been the heaviest milker; but the eye and the size of the bucket proved to have been at fault, and "Spot" had really given 19 lbs., whilst "Jennie's" came to 16.

I had another talk to Tom before leaving, and secured a promise from him that the system of recording results would be persevered with till the end of the month at least. At the end of the month Tom wrote me to say that he had ruled and set up another chart for the next term, and referred to the yields of the big brindle cow and some other members of the herd.

It was some two years later that I visited Mr. Brown's dairy farm, and Mr. Brown did not seem less pleased to see me than his intelligent son. An exercise book was produced a few minutes after my arrival, and I was shown the actual returns secured from each and every cow.

On asking what the cheque from the factory this month was, I was smilingly informed that it was £59 odd from 61 cows.

"And the price paid by the factory?"

"Was $8\frac{1}{2}$d., why, just the same price as for the month you were here before."

Tom said—"My word, sir, we found out some things before many months had past, we learned that some cows were little better than boarders who didn't pay their bills in full, and it was easy to show Dad that they were not paying for their grass and attention, so they were quickly put dry, fattened, and sold to the butcher, and now we know which cows pay us best, and which to rear the heifer calves from. Although you say the returns are good, we are quite satisfied that in another couple of years we will be getting much larger returns. There is really no limit to this method; we can see that if all the cows were as good as the best twenty the annual returns would be increased by 50 per cent.; we also see great possibilities in the testing of the cows. For the last three months we have had samples tested by the local factory manager, and those range from 3.2 up to 4.8 per cent. butter-fat."

Tom then produced the monthly charts, the first three of which were of brown paper, the others being of good white, serviceable paper, specially procured for the purpose. "For a time you will see they were made rather dirty, but I got a strip of tin 6 inches wide to put across the chart for the milkers to rest the heel of their hand on when entering up the yields. That kept them much cleaner." "What means this abrupt variation in the figures ?" I remarked, in noticing a sudden falling-off in the yields in one of the charts. "Ah! that happened when Frank got a dog to help him bring up the cows. The dog used to race them like anything. Rover sometimes singled out a cow, and chased her round the paddock for all she was worth. This went on for a while, and the irregularity in returns was puzzling us all, until one day the dog was run over by a cart and killed. From that day on the yields in every case were more regular; in fact, an improvement towards the former good consistent supply took place, as you can see. No more dogs amongst our cows after that."

On turning over the monthly charts, I came to another one, in which a pronounced falling-off was indicated. On asking for a reason, Mr. Brown said, "That happened when Smith's lambs died with the cold. The equinoctial gales were on—they lasted nearly a fortnight. You'd have thought that Bass Strait was full of icebergs, so cold was it. We put the cows in the sheltered paddock after the second day. There are six chains of boxthorn hedge in the south-west corner, and the cows used to get down near it. They were given some hay, too, and you see the figures at once showed an improvement. And you see those four cows that came right up again in their yields? They were ones we rugged as an experiment."

"And this?" pointing to a sharp increase. "Ah! that occurred when the cows were changed into a fresh paddock, which had been spelled for a time. You can find a number of variations in the earlier charts, the reason for which we omitted to note. Now, however, you see, everything is jotted down, it does not take long, and there is money in it." And as I left Mr. Brown's last words were, "There's money in it, my man."

If preferred, weekly record sheets, one of which is reproduced on the opposite page, may be kept.

Record sheets, similar to those set out on pages 290 and 293, may be obtained from the Secretary, Department of Agriculture, Melbourne, at a cost of 6d. per dozen, post free. The sheets are of suitable size and strength for cowshed use. When ordering, applicants should mention whether the weekly or monthly sheets are required.

MILK YIELDS FOR WEEK ENDING 21ST APRIL, 1906.

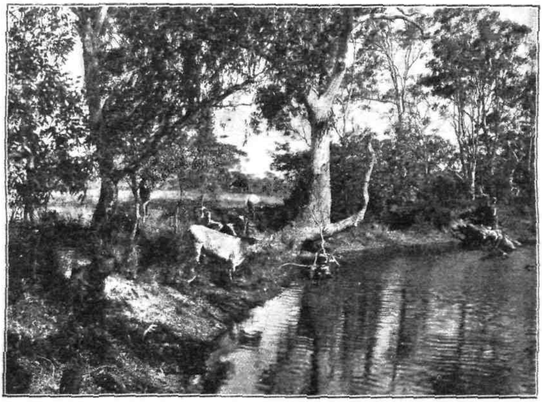
Name.	Weeks calved.	Sunday.		Monday.		Tuesday.		Wednesday.		Thursday.		Friday.		Saturday.		Total.
		M.	E.	M.	E.	M.	E.	M.	E.	M.	E	M.	E.	M.	E.	
Bessie	32	9	4½	7½	5	8	5½	7	5	6	6	5½	5	6	4½	84½
Linsey	26	11	4½	9	8½	9	7	10½	6	10½	4½	10½	4½	9½	6½	121½
Brindle	23	10	5	9½	5	10	5	9	6½	8	5½	8	5½	6	6	99
Marigold	21	11	4½	9	6	9	6	9½	6	10	5	10	4½	10½	5	106
Dandelion	20	8	6	8½	7½	9½	7	9½	6½	9	5	10	5	8½	6	106
Buttercup	20	15	7	10½	8½	13	9	12½	9	13½	8	11½	7	11	7½	143
Pet	17	8½	4½	8½	6	9	6	7½	7	7	6	7	6	8	5	96
May	14	14	6	11	6½	11½	6½	10	7	11½	5	13	5½	10½	6	124
Brownie	14	8½	5	9½	5	9	5½	8½	5	9½	5½	8	5	8½	5	97½
Lady	9	9½	8½	9	12	9	12	9	12	10½	9	9½	10½	10	10	140½
Polyanthus	9	8	6	7	7	6½	7	6	6	6½	5	5	6	5	6½	87½
Fanny	7	10	10	9	11½	9	11½	9	13	9	9	10½	10	9½	9	140
Silver	4	16	8½	13	11	14	11	14½	11	17	10½	14	9½	15	9½	177½
Jessamy Bride	3	10	9	9½	10½	9	10	9½	10	9	10	9	10½	9	9	134
White Aster	2	17½	8½	15	11	17	11	17	12	18	10	14	10½	17	11	189½
Bright Star	2	6½	5	7	6½	5½	6½	6½	7	6½	7	6½	6½	6½	6½	90
Semaphore	2	17	7	18½	8	18½	9	19	8	20	9	20	9	16	8½	187½
Saffron	2	25½	9½	24½	16	25	12	27½	12	30	11	30	11	28	12	274
Fawnie	2	17	7	14	11	15½	10½	13	10½	15½	7	18	9	15	11	184
Pansy	2	14½	6	13	7	14½	7	13½	8	15	7	14½	7	13	7	147
		256½	127	222½	169½	231½	165	228½	167½	242	145	234½	147½	222	151½	
Daily Totals ...	...	383½ lbs.		392 lbs.		396½ lbs.		396 lbs.		387 lbs.		382 lbs.		373½ lbs.		2,729 lbs.
		15	9	13½	12	14	11¾	13¾	12	14¼	10¼	14	10¼	13	10½	
Cream Results	...	24 lbs.		25½ lbs.		25¾ lbs.		25¾ lbs.		24½ lbs.		24¼ lbs.		23½ lbs.		173¼ lbs.

Daily average of herd—20 cows = 390 lbs. Daily average per cow = 19½ lbs.

SPECIMEN MILK RECORD SHEET.

Willsmere Park.

A graphic method of recording milk yields is adopted by Mr. Arthur Wills, of the noted Willsmere Park Dairy, at Kew. Mr. Wills owns the Willsmere Park property, which is romantically situated within five miles of the Melbourne Post Office, and for aught that can be seen to the contrary it may be in the Upper Murray regions—the only difference being the absence of cockatoos, parrots, and hares. The farm is undulating, and has a large frontage to the River Yarra, along the banks of which ancient red gums and even patches of scrub still exist. However, it is not my purpose to describe the farm or cows in this article so much as the method of keeping records. At the same time, I cannot refrain from making a short reference to the dairy.

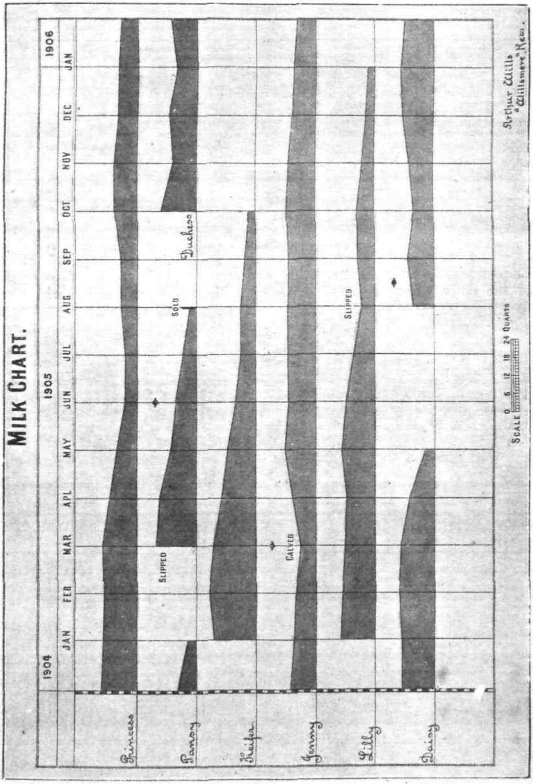


ON THE YARRA.—5 MILES FROM CITY.

The milking-shed is beautifully situated, well paved and drained, and amply lit and ventilated; so well kept is it that it might at any time be made to serve almost as a dining hall. Mr. Wills himself is of an artistic temperament, and takes great pride in personally managing the property, and is conversant with every detail outside on the farm, as well as inside the dairy.

When milk is taken from the cow, the bucket is suspended on a spring balance with a circular face, and instead of the usual gradation into pounds, paper is gummed over the scale, and graduated to show quarts and fractions of same, and in lieu of figures being inserted on the recording chart, a line is drawn as indicated in the accompanying illustration. Each sixteenth
ca.r an inch from the base represents a quart, so that if the line be ¾ of an
stre. from the base, it indicates that the yield is 3 gallons, and the course
heth line is up or down from day to day, according to the quantity of
en.

The space between the base and the line is coloured and the yield illustrated in a graphic manner. The chart also provides for the noting of

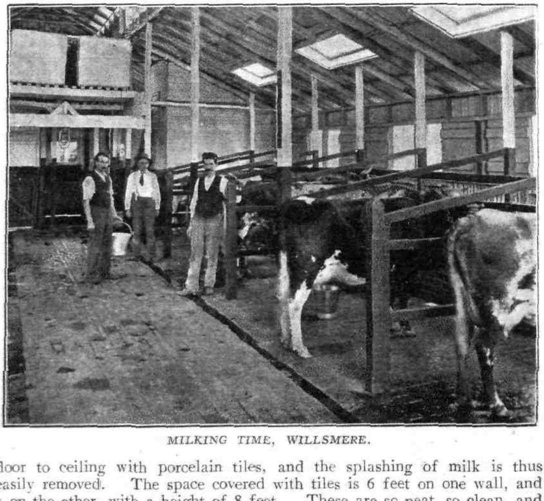


the date of expected calving, the actual date of calving, the price paid for the cow, and in the event of her being sold, the price realized, and all such information. The illustration, however, is so clear and suggestive that

no description is required. The milk is then poured into a can supported by galvanized iron brackets on the wall; a tap regulates the flow over a

FARMSTEAD, WILLSMERE.

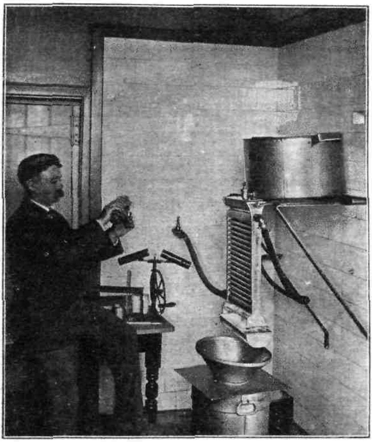
Laurence cooler suspended from the end of the wall brackets. The corner of the dairy where the cooling of the milk is carried out is lined from



MILKING TIME, WILLSMERE.

floor to ceiling with porcelain tiles, and the splashing of milk is thus easily removed. The space covered with tiles is 6 feet on one wall, and ... on the other, with a height of 8 feet. These are so neat, so clean, and stre..ppropriate that similar provision ought to be adopted by every dairy- ...beth...

Instead of the orthodox Laurence cooler with a fixed spout at the foot to catch the milk and deliver into a strainer—every dairyman knows how those fixed spouts get bent and provide awkward angles which are difficult to clean—Mr. Wills knocked the fixed spout off his cooler and suspended a movable one, so that when the cooler has to be cleaned, the spout is taken off and put in the wash-up trough, as well as the other appliances. The cooler is thus more readily cleaned.



TESTING ROOM.

The wash-up room is large and suitably furnished. It has a good cement floor well drained, and contains a copper for boiling water. A galvanized iron wash-up trough, and moveable stands of galvanized iron for holding dishes, cans, buckets, &c., &c., also form part of the equipment. The man in charge of this department is worthy of special praise for the condition in which the place is kept. When washing milk delivery cans, the taps are always screwed out and taken to pieces, a detail which is often overlooked, even in butter factories.

Mr. Wills has a capacious silo filled for the winter. He grows lucerne, keeps good clean grass paddocks, feeds his cows well, and a better object lesson in cleanliness and method in the dairy could not be desired.

FLAX AND LINSEED INDUSTRY.

Jos. Knight.

WILL FLAX-GROWING PAY?

This is a question frequently asked, at the agricultural shows and elsewhere, by those who are desirous of doing something in the way of giving it a trial. The following is a statement of the cost of production and the returns per acre:—

Income.		*Expenditure.*	
From 10 bushels linseed, per acre	£4 0 0	Rent per acre... ...	£1 10 0
From 5 cwt. fibre ...	11 5 0	Cultivation and seed ...	1 5 0
		Harvesting (with binder)	1 0 0
	£15 5 0	Threshing	0 12 6
	8 12 6	Spreading	0 7 6
		Drying and stacking (ready for manufacture)	0 7 6
Balance, profit per acre	£6 12 6	Manufacturing ...	3 10 0
		Total	£8 12 6

As to the yield of seed here given, I may say that it is below the average, and the expenditure is on a rather high scale. The above fully answers the question: "Will flax-growing pay?

SOILS SUITABLE.

Flax is usually looked upon by those who are not acquainted with it as a plant requiring a damp or moist situation, but this is a mistake, as it will not thrive with excessive moisture. The plant loves a dry, warm, loose soil; where it is strong and stiff it must be well cultivated, so as to give the roots a free course during the early stages of growth. It matures rapidly in spring, and ripens its seed before the cereals, and if not assisted in the way suggested will become stunted and valueless for fibre-making purposes, although probably giving a fair return of seed. Generally speaking, the soil suitable for producing a crop of cereals will do equally well for a crop of seed and fibre, with a slight additional working as suggested.

The accompanying illustrations, marked 1, 2, and 3, give the plant and the two methods of growth. Fig. 1 shows the plant as cultivated for seed, fig. 2 as grown for fibre and seed, fig. 3 plant in flower with boll and seed. It will be seen by No. 1 that the plant, when given room to develop, throws out its lateral, or seed-bearing, branches, which render it useless for fibre-making purposes. Fig. 2 shows the plants grown close together, and drawn up tall and branchless, excepting just at the top, which, as may be expected with an imperfectly developed plant, will be less prolific in its seed-production. It is a difficult matter to say definitely what part of the State is most suitable for the crop, since it is found to do almost equally well in nearly all districts. The nature of the soil, however, is of some importance; it must be warm, dry, and free; cold, wet soils should be avoided. A free soil is specially valuable, as, before sowing, the land must be well pulverized. Excellent results are obtained in the loose mallee

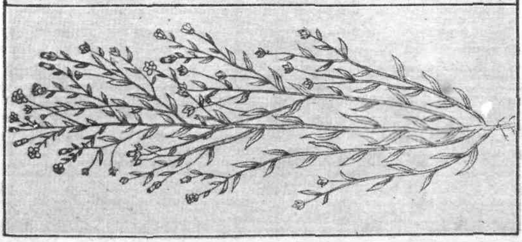


FIG. 1.—FLAX GROWN FOR SEED.

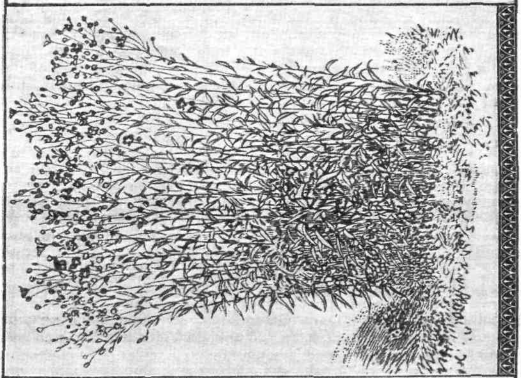


FIG. 2.—FLAX FOR FIBRE.

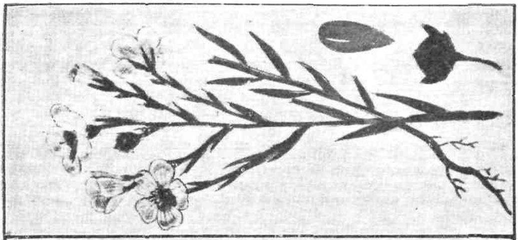


FIG. 3.—FLAX PLANT.

lands, when there is sufficient moisture for the growth of the plant. Generally it may be said that where a good crop of wheat can be obtained flax will do equally well, though wheat can stand a harder seed-bed. In Gippsland and the coastal districts there is less danger of growth being checked in the spring from want of moisture, and there is also a wider range of season for sowing.

Preparation of Soil.

No portion of the work pays better for attention than this. The seed requires a free soil to strike its roots down, as it is usually sown thickly, in order to produce tall, branching stems. It has little or no room for lateral roots, and has to seek below, to a large extent, for its supplies. Hence, where the soil is indifferently prepared, the young plants suffer. The soil should be pulverized to the full depth of the ploughing, and whilst deep cultivation is to be recommended generally, it is not at all times advisable. There is nothing exceptional required by this plant when grown under ordinary conditions, but thorough cultivation must be given. The seed is small, and requires to be kept close to the surface, which is impossible without proper pulverization. The advantage of this will be felt in all the various after operations, and should not be lightly overlooked, which, unfortunately, is too frequently the case.

Varieties.

There are many varieties in cultivation elsewhere, but only three are grown in this State. The first is known as "Riga," another as "White flowering Belgium," and the third, "Large Red," or "Calcutta Seed." This last is grown for oil-making purposes only, whilst the two former are employed for both fibre and oil production. The White-flowering Belgium is a spring variety, and is much more rapid in its growth, maturing a fortnight or three weeks earlier than either the Riga or Large Red; and whilst its yield of fibre may not be quite equal in quantity to the Riga, it nevertheless gives good returns when sown under proper conditions. One of its chief advantages is that of early maturing, as there is much danger with the late kinds being attacked by the boll worm which pierces the seed-pod, and totally destroys the seed.

Seeding.

The amount of seed necessary per acre depends on the nature of the crop required. When grown for seed purposes only, much less is needed than if for fibre, and the plant is encouraged to throw out lateral branches and to develop seed, whilst that grown for both fibre and seed production is sown close. The amount of seed required for fibre purposes is about one bushel (56 lbs.), whilst for seed only one-half to three-quarters of a bushel would be sufficient. The old system which was practised here and elsewhere, of sowing two and three bushels per acre, is a mistake.

Sowing.

The only method hitherto employed has been to sow broadcast by hand. Though drilling may be adopted for a seed crop, when fibre is wanted it

must be sown broadcast. This does not preclude the use of machinery, as some drills are fitted so as to distribute the seed evenly over and on the surface. Their use would prove a great advantage, as there is no more difficult crop to sow satisfactorily. When unevenly sown, the produce is also uneven, the stems differ in size, and a coarse appearance is given to the whole fibre. No doubt, machinery, when properly adjusted, will materially assist in preventing any defect of this kind. Those unacquainted with hand-sowing will do well to mix the seed with dry earth or ashes, to give bulk, so that the seed will be more evenly distributed.

It is impossible to lay down any hard and fast rule for the time of sowing, as the seasons vary; but it may be said that the proper time for sowing cereals, such as oats and wheat, will be found to suit linseed. What should be aimed at is to get the young plants thoroughly established, but not too far advanced, before the winter sets in. If too forward, they are apt to throw out the bloom, or become heavy and lodged. It cannot be fed off like wheat, when winter-proud, hence, in seasons when the rains enable the ordinary farm crops to be put in early, it would be well to leave the linseed till the last. It is not injuriously affected by frost, as generally supposed, and no danger need be feared from this source. Rapid growth is made in spring, but if checked for want of rain the plants become stunted and short. More disappointments have been caused by spring sowing than all others, as our seasons are quite unsuitable for this. It has frequently been found that self sown seed will produce excellent results, whereas a crop put in in the spring has been scarcely long enough to harvest. The growth must proceed unchecked, when once the spring has set in, and this cannot be relied on with late sowing under the conditions prevailing here. In humid districts such as Gippsland, there is a much wider range of season for sowing, and fair crops may generally be secured if put in even in July or August, but May or June is much preferable, and in the northern areas the sowing should be not later than May, or two first weeks in June.

Linseed, like most other small seeds, fails to germinate when deeply buried. Under such conditions, many lie dormant in the soil, and when turned up by subsequent tillage, grow, and become a nuisance. The soil should be brought to a fine tilth, the seed may then be sown on the surface, and a brush harrow drawn over it; in some cases a light roller answers the purpose. But where the soil is subject to crusting on the surface, rolling is not advisable, as it closes the pores and prevents the air from permeating the soil.

MANURING.

A series of experiments will be conducted in various parts of the State to test this question, as no doubt there are large areas of land, which are considered too poor to produce a crop, could be made to yield a fair crop of both seed and fibre by the aid of a suitable manure. I have noticed frequently that when manures are applied they naturally increase the bulk of crops produced; but I also notice that in the supplement of the *Journal of the Board of Trade*, dated 31st December, 1903, a series of experiments conducted with various manures are published, which go to show that, whilst increasing the bulk produced per acre, they in no way increase the yield of fibre, but rather reduce it.

WEEDING.

Little can be done with this crop after it becomes advanced in growth, and where weeds, such as dock, thistles, wild turnips, &c., show themselves, they should be removed, as they not only cause inconvenience and give a lot of unnecessary labour when treating the crop for fibre-making, but, to a certain extent, the sample of fibre produced is affected. Flax requires clean land; in many cases new virgin soil is chosen on account of its freedom from weeds, and the plant adapts itself well to these conditions. As to its power to suppress ordinary weeds, it will do so when fairly established, but those referred to must be removed during the early stages of the plant's growth.

STAGE OF RIPENESS FOR HARVESTING.

This question seriously perplexes inexperienced growers. They are told by old authorities that it must be taken when just past the blooming stage, and that, if allowed to go much beyond that, it is useless for fibre, and, strange to say, many writers lay this down as something which must be scrupulously observed. During the early stages of my labours in advocating the practice of securing a full crop of both seed and fibre, I met with considerable ridicule, and found it necessary to travel with samples of these products, and even then, in many cases, failed to convince the sceptical, as it was said that the fibre was valueless. Trade samples of fibre were then secured by our London agent, and when submitted to these critics they invariably, but unknowingly, reversed their decision by selecting the local article as better.

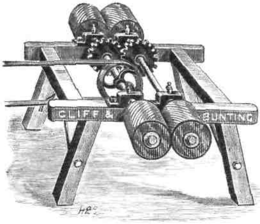
That seed and fibre can be secured from the same crop has been proved over and over again. To obtain the best sample of seed, the crop should be fully ripe, and this will give—contrary to European precedent—an excellent fibre, such as we have been putting on the market, realizing £45 per ton. Upward of 50 samples have been obtained from various sources, all of which are the produce of fully-matured crops. I have met a few who still adhere to the opinion that cutting while in bloom is the proper course, but such men are not found in the fibre market. Unfortunately, agricultural societies do much to maintain these erroneous ideas. With good intentions they offer prizes, and appoint judges who carry with them their old world prejudices.

The plant matures its seed somewhat unevenly. The top seed-bolls ripen first and open. When this stage is reached the crop should be harvested without delay, and treated similarly to oats or wheat, and it is advisable to get it in stooks as soon as possible, to avoid loss in seed. It will be found that the unripe bolls fill up considerably when in the stook.

MODE OF HARVESTING.

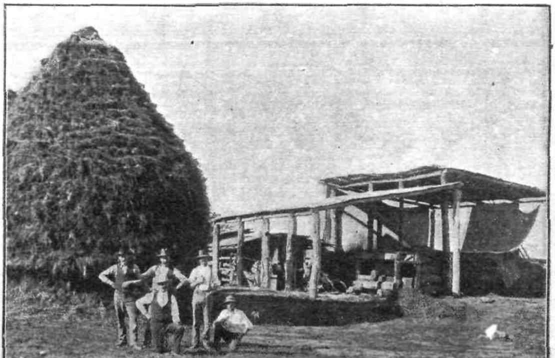
One of the most difficult ancient notions to break down is in connexion with the harvesting operations. The recognised method is pulling up by the roots, and it is surprising what laboured arguments are put forth to prove that it is absolutely necessary and indispensable. It is said that the roots must be on the plant, or the oil escapes, or that the water gets in the
em ; in fact, all sorts of troubles are predicted if it is done in any other
Th Fortunately, success is achieved by the simple method of cutting
Though l ordinary reaper, or even with a reaper and binder; and, further,

where the land is properly prepared, the cutting is accomplished without loss of fibre, for no fibre exists in the roots, or for one or two inches of the lower portion of the stalk, and modern mowers are now made to cut so



THRESHER OR BOLL CRUSHER.

close that the stubble is scarcely noticeable. If the old system was necessary, it would be folly to advocate flax cultivation in this State, as the labour required is not available for what is, at best, a disagreeable task. Most growers adopt the system of cutting with a binder, and, with the assistance of a man to take the sheaf from the machinery, the work is well



STACK.

done. A few prefer the ordinary mowing-machine, with reaper attachments, as they state the best results are obtained by that means. This considerably simplifies flax cultivation, and renders it much more attractive.

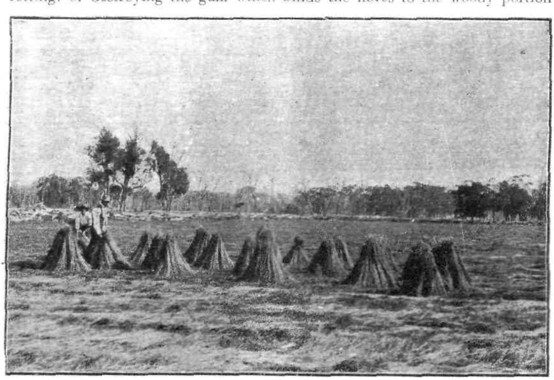
The after operations are the same as in other crops; the sheaves are stooked until dry, when they are stacked ready for threshing.

THRESHING OR BOLL-CRUSHING.

This operation is carried out in various ways. The old system of spreading out on the floor and bruising the bolls with a flat mallet is altogether too tedius; so also is the rippling, and the ordinary thresher is expensive. The illustration on the preceding page shows a machine made by Messrs. Cliff and Bunting. Many of these are now in use, and work well. The seed is afterwards passed through a winnower, and easily cleaned. It may be pointed out that the sheaves are not untied, and that the heads only pass through the rollers. A spring is used to keep the two rollers together, and give the necessary pressure.

RETTING.

This is perhaps the most difficult operation to learn. It consists of rotting, or destroying the gum which binds the fibres to the woody portion



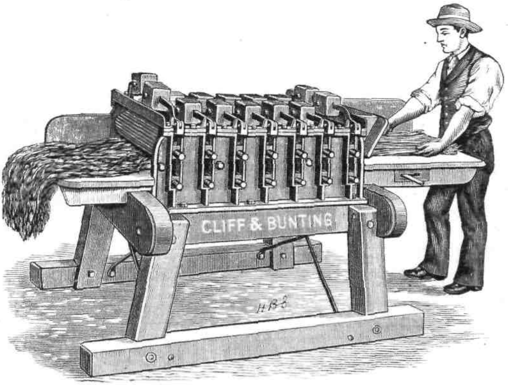
DEW RETTING AND DRYING.

of the plant, and it requires to be done in such a manner as to avoid the decaying process being carried so far as to affect the fibre. There are various methods by which this is accomplished. In European countries the straw is placed in water, sometimes running streams. In Ireland and in other countries pits are used, which are considered by some to be an advantage. This system has been carried out in this State, but its disagreeable nature creates an unfavorable impression, as it gives off an offensive odour, and pollutes any water-course into which the discharge is made. It is entirely unnecessary for the production of fibre, and is not to be recommended.

DEW RETTING.

This is by no means a new process. It has been employed for ages past for both flax and hemp. Acres of ground are covered in the manner shown in the illustration. This method of retting flax, although simple and cheap, costing as it does about 15s. per acre, is the one operation which requires skill and care. If insufficiently retted, it is difficult to treat, and if overdone the fibre is seriously injured, and its value reduced. The test is easily made, for as soon as the fibre separates freely from the inner or woody portion, when broken, it may be considered sufficiently far advanced to be removed, and when dried the decay is arrested; the material may then be stacked and treated as opportunity permits. The knowledge, with a little experience, is easily acquired.

The system of degumming flax straw is likely to undergo a revolution in the method of treating it. A company is now being formed in the city who will purchase the straw either threshed or unthreshed, and intend destroying the gum referred to by a chemical process. Should this company be able to treat the product on commercial lines in the same manner as that



BREAKER.

done in the experimental work there will be a big future before them. They are having extensive machinery erected, and expect to be in full working order within a short time. The samples of fibre produced by this process appear to be superior to that of the ordinary retting, being strong, clean, and having a white lustrous appearance. The work of degumming is completed in two hours, and when dried the straw is ready for the operation of extraction, which is similar to that of straw which has been retted in the ordinary way—that is, by breaking and scutching.

The promoters of this company purpose erecting treating plants in the various flax-growing centres, and carrying on the work in a very large

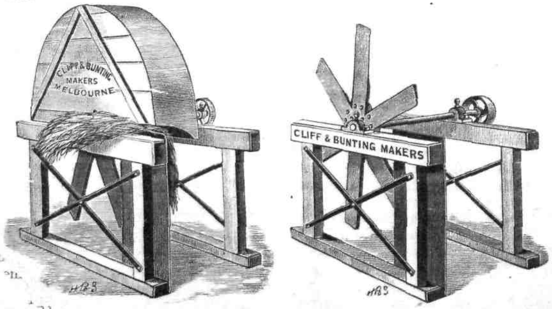
way. I am perfectly satisfied in my own mind that this method is an improvement on the old system; but I am unable to say definitely that the company will be able to carry out the work in such a way as to make it a financial success. The advantages of this system of purchasing flax straw to small growers will be considerable, and will enable them to market the product without incurring the expense of providing machinery.

BREAKING AND SCUTCHING.

This consists of crushing the retted straw betwixt fluted rollers, and afterwards passing it through a beating or brushing process. The first

DOUBLE SCUTCHER.

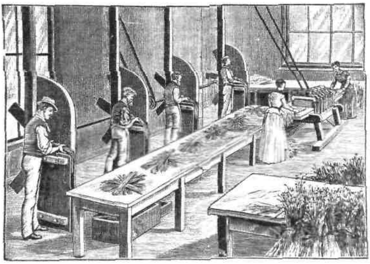
operation breaks up the non-fibrous portion of the plant in short bits from a half to one inch in length, which is readily separated in the scutching process.



SINGLE SCUTCHER.

The whole of the machinery is driven by a small oil-engine, a 4-horse-power being considered sufficient. The accompanying illustration shows a factory as fitted up by Messrs. Cliff and Bunting. The cost for machinery and fittings, exclusive of the engine, amounts to about £75; its capacity is said to be about 4 cwt. of dressed fibre per day.

After passing through all the various stages, the fibre is put up in bales similar to wool-packs, weighing from 4 to 5 cwt. each. The tow, which consists of broken and out-of-place strands of fibre, is cleaned and served in a similar manner, and as the value of this is only about one-third of ordinary fibre, skill in manipulation is shown by reducing this to a minimum.



INTERIOR OF FLAX FACTORY.

The Department of Agriculture has now secured a complete flax treating plant with power to drive same. It is intended to give demonstrations in various parts of the State, and to treat small lots for growers, in order to show what can be done. No doubt had this system been adopted when the bonus was in force, much better results would have been achieved.

THE COMMERCIAL VALUE OF THE INDUSTRY.

As regards the market for flax, there is no need to look beyond our own State, as the local demand is more than we may reasonably hope to satisfy for some considerable time to come. The inducements offered by manufacturers show clearly a desire for a home supply. Messrs. Miller and Co. have for many years paid special attention to the development of flax-growing, and have imported the latest and most approved machinery to assist those engaged in the industry. They do not, of course, pretend to advise on questions relating to its growth and cultivation, but offer liberal concessions in regard to machinery required, and also are prepared to purchase the fibre at a price equal to, or in advance of, that given for the imported.

It has been asserted in some quarters that flax-growing is a decadent industry, and that the fibre and oil have almost disappeared from the list of the great products of the world. Quoting from the *Journal of the Department of Agriculture and Technical Instruction for Ireland*, I find that the linen industry occupies the third place in importance in the British

textile industries, the total value of linen manufactures exported from the United Kingdom for the year 1904 amounting to £5,727,054.

The sources of supply may be shown from the yields of flax in the various countries as follow:—

Country.	Yield of Flax in Tons.			
	1899.	1900.	1901.	1902.
Russia	185,703	275,000	310,527	497,341
Austria	41,090	49,518	54,567	50,659
France	12,423	19,103	24,404	15,812
Italy	18,400	18,400	18,400	20,000
Germany	16,875	15,590	13,125	11,250
Poland	13,500	13,500	13,323	13,500
Belgium	11,000	10,919	9,674	9,674
Ireland	6,743	9,479	12,797	10,975
Hungary	9,257	9,814	9,883	12,199
Holland	4,902	6,751	8,275	8,552
Roumania	3,590	5,965	9,393	7,625
Other countries	3,000	3,000	3,000	3,000
	326,483	437,039	487,368	660,110

The following table gives the quantity and value of the raw material (flax, tow, &c.) imported into the United Kingdom during the year 1904. The figures are taken from the *Journal of the Department of Agriculture and Technical Instruction for Ireland*:—

IMPORTS OF FLAX AND TOW INTO UNITED KINGDOM.

From.	Year 1904.	
	Quantities.	Value.
FLAX.	Tons.	£
Russia	39,660	1,523,706
Belgium	17,494	1,094,987
Holland	3,415	171,542
Other countries	1,445	46,126
TOW.		
Russia	7,423	233,259
Other countries	5,480	115,855
	74,917	3,185,475

It will be seen from the above table that Russia supplied 47,083 tons of flax and tow, almost two-thirds of the total quantity imported.

The average cost per ton of flax, used in the linen trade of the United Kingdom (1902) is as specified:—Belgian, £64; Irish, £50; Dutch, £49; French, £44; Russian, £37.

CONCLUSION.

We have seen that this industry is an important one—a fact recognised, not only in Victoria, but in other countries as well. In Ireland we find the associations import teachers from Belgium to show the farmers the best means of treating the flax crop. In the report of 1900 it was stated that arrangements had been made for the introduction of an expert with machinery to travel the district shows, and give object lessons in its manipulation. When we consider that this is one of the oldest and most extensive fibre-producing countries of the world, it is not unreasonable to suggest that something of a similar nature should be done here; but to introduce an inexperienced hand to the altogether foreign conditions would be to court failure. There is an abundance of evidence of this existing already. To be successful it will be necessary to adopt a system suited to present conditions, and this, coupled with the use of approved modern appliances, is all that is required. The French Government is alive to this fact, and is now giving £1 5s. per acre as a bonus for flax cultivation. Russia is offering liberal concessions to those entering into the industry. But in a young country like this, with virgin soil and a superior climate, the industry should flourish.

PROGRESS IN THE KING RIVER VALLEY.

Temple A. J. Smith, Tobacco Expert.

That portion of the North-East, on the King River, embracing Whitfield, Edi, Cheshunt, and Moyhu, is comparatively little known to the general public. Yet it is one of the most suitable districts in the State for close settlement and general farming. Almost any crop that is grown in Victoria will thrive well, and the climate and soils are eminently adapted for intense culture.

Maize, hops, tobacco, potatoes, broom millet, cereals, and many kinds of fruit and nuts are grown with success. Dairying is largely carried on, the fresh, pure water and cool nights, combined with the easy growth of fodder crops, greatly assisting this industry. Sheep and cattle fatten readily on the natural and artificial grasses on the river flats and foot hills.

The various permanent creeks which feed the river have each their own valleys, for the most part consisting of rich soils, and capable of irrigation, and the greater part of the river flats is also irrigable, though too little has been done in this important direction by settlers. The successful example of the few, however, who use pumping plants is being followed by others, and in the near future a large proportion of the settlers will see the benefit of making crops practically certain by utilizing the beautiful stream flowing past their properties. The valley of the King River is served by the first narrow-gauge railway built in this State, connecting with the main line at Wangaratta, one of the most thriving country towns in Victoria, situated forty-five (45) miles from the New South Wales border, on the main line to Sydney. This is an advantage to the district, inasmuch as the residents in the drier areas north of the Murray River can be supplied with the various crops which cannot be grown in their own vicinity, quantities of fruit, potatoes, pumpkins, chaff, &c., finding their way to the sister State. A generally dry season means increased returns to the favoured settlers in this valley, as droughts, in the real acceptation of the term, are unknown, and prices for their produce at such times are higher. In past seasons chaff has been sent to

New South Wales, and sold as high as £11 per ton, and pumpkins at £9 per ton, potatoes also realizing at times very remunerative prices. The altitude varies from 800 feet to 1,200 feet in the valley. The scenery is very pretty and further back in the mountains very fine, the falls at Mount Cobbler being frequently visited by tourists, while smaller falls are to be found amongst the lesser hills. The rainfall averages close

"MAMMOTH" PUMPKINS.

"PINK EYE" POTATOES.

upon 40 inches, the drier months being January, February, and March. Autumn rains are, however, usually to be expected in the two latter months, and it is rarely found that no rain has fallen in either of the three months mentioned.

SOILS.

RESULT OF ANALYSIS OF SOME SOILS FROM THE KING RIVER VALLEY.

	Parts per 100,000.			
	Nitrogen.	Phosphoric Acid.	Potash.	Lime.
Byrne, Moyhu	350	340	490	380
Neylon, Moyhu	190	480	580	530
Smith, Cheshunt	190	320	560	480
Howard, Cheshunt	180	350	360	520
Hall, Whitfield	110	180	340	220
Swan, Londrigans	100	170	390	230

K. The soils of the flats consist chiefly of alluvial deposits, varying in Fren. pth to 14 feet, and containing a fair percentage of sand. They are he greater part naturally well drained, having a porous subsoil, with bottom. The terraces and foot hills are chocolate, with clay

subsoil, in some cases reaching a depth of 25 feet. The hills and table lands on the western side of the river carry rich volcanic soils.

Maize.

That maize can be successfully grown is shown by the accompanying illustrations, the subjects of which were grown, without irrigation or

"Silvermine" Maize,
Edi Experimental Farm.

"Hogan's Early Red" Maize,
Mr. Anderson's Farm, Cheshunt.

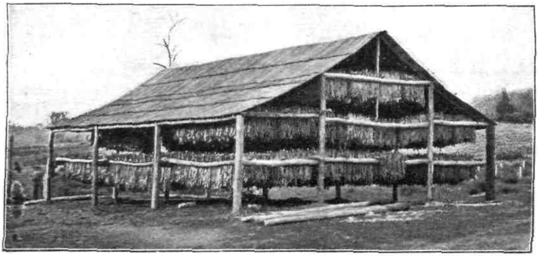
manures, in a season drier than usual. The stalks measured up to 13 ft. 8 in. in height, and are bearing from two to three large cobs each. There are several other fine crops in the district, both for grain and fodder, yet the acreage devoted to this crop is not one-hundredth part of what could be produced. Nine plots of different varieties have been tried during the present season at the Government Experimental Farm, Edi, all of which have made good growth, bearing fine cobs. The varieties showing most promise are Hogan's Early Red and Silvermine. Of the others, Ninety Day, Eclipse, and Leaming are good seconds. The first-named should be admirably adapted for silage use, keeping green late into the season with a long solid stem.

Potatoes.

Potatoes are grown in limited areas by many of the settlers, the yields averaging from 4 to 8 tons. This is a crop also that might be more extensively planted with advantage, and with judicious selection of seed the product would be equal to any grown in the State. The field shown in the photograph is a 3-acre crop of Pink Eyes, grown by Mr. Maconachie, a Whitfield settler, 4 cwt. of a special fertilizer being used per acre. Brown's River, Peach Bloom, and several of the early varieties also do well.

TOBACCO.

The district has for many years borne a reputation for supplying the best pipe tobacco grown in Victoria, and the quality has been steadily improving of late years owing to the introduction of better varieties, and



TOBACCO SHED (UNFINISHED), SHOWING TOBACCO JUST HARVESTED.
Crop (17 acres) estimated to yield 10 tons.

improvement in general treatment. A better class of curing shed has also been adopted by some growers. The illustrations show a new shed of Mr. Gibson's, with a quantity of new tobacco, just harvested, hanging on the tiers. It will be seen that this shed is not complete, the sides

TOBACCO SHED, 32 × 40 FEET, SHOWING SHUTTERS FOR VENTILATION OR CLOSING UP.

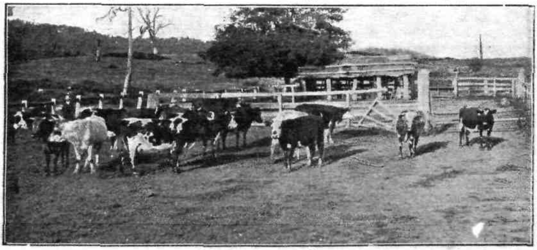
Built of bush timber. Capacity, 3 tons cured leaf. Cost £30 for labour and material. Shed is also used for drying Broom Millet.

having yet to be closed in. Latterly some very good cigar leaf has been produced, and some highly remunerative returns made by several individual growers. A grower at Moyhu, who cultivates 30 acres annually, has sold on an average leaf to the value (gross) of £750 per annum over

the last three years, off this area. Another grower at Cheshunt realized (gross value) £523 and £417 from 22 acres. In both cases the land was unmanured. A large proportion of the crops is sold to Adelaide buyers.

TOBACCO CROP AT CHESHUNT.
Lacks variety in foreground.

This particular crop is admirably suited to small holdings. The cost of growing is from £6 to £8 per acre. A photograph of an eight-acre crop, machine planted, shows in the foreground some fine plants of the



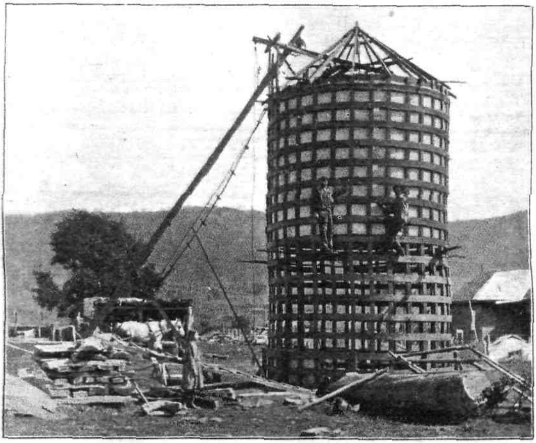
PORTION OF MR. D. GIBSON'S DAIRY HERD.

Lacks variety, grown at Cheshunt. A crop of Blue Pryor tobacco at the Edi Experimental Farm is shown on the cover.

DAIRYING.

Nine-tenths of the farmers are engaged in this important industry, and the butter shipped from the district is of very superior quality, bringing

prices as high as 116s. per cwt. With greater attention to the growth of fodder crops, the universal establishment of silos, and better housing of the stock, the output might be doubled. Several silos are now being erected on approved plans, as specified in the *Journal*. The over-ground silo, shown in the accompanying illustration, which is being erected by Mr. Maconachie, is an example of what can be done by a handy man. Mr. Maconachie never saw a silo prior to erecting his own, which is excellently constructed. Several other silos, both pit and over-ground,



OVERGROUND SILO BUILT BY MR. MACONACHIE.

are also being made by neighbours on lines laid down in the *Journal*. Some stacks of ensilage are also being built.

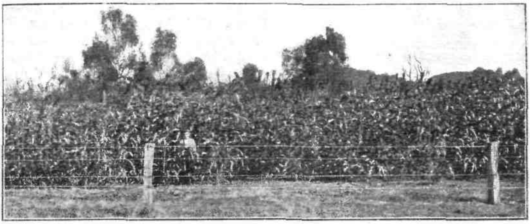
BROOM MILLET.

This crop has been more extensively grown by Whitfield settlers during the last two years, and promises to be most useful, as well as remunerative. The fibre of King River production is spoken of as superior in quality to that grown in New South Wales, being more flexible and not so coarse. The yield of fibre averages, approximately, 8 cwt. per acre, valued at £25 per ton. The seed yield is from 5 to 10 bags per acre, and it sells at 5s. to 6s. per bag. The crop is harvested on the green side, and the stalks can be utilized for ensilage after the crop has been taken off. The labour required to produce the crop is considerable. The [illegible]d must be kept clean and the plants thinned out. The harvesting [illegible]t be accomplished by machinery, each head of millet having to be [illegible] hand. Sheds are necessary for drying purposes. The average [illegible]rowing and preparing for market is about £4 to £6 per acre.

The photograph of Broom Millet represents a crop of 22 acres, the height varying from 6 feet to 12 feet. The variety is the Dwarf Missouri, the estimated yield being 9 cwt. per acre. No manure was used.

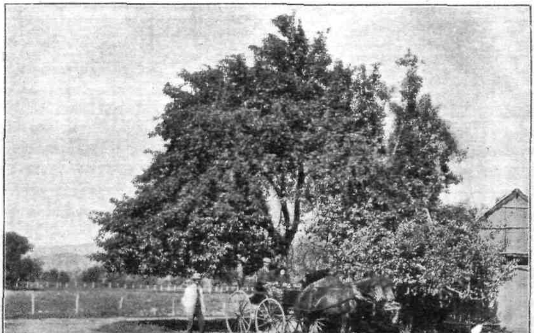
PUMPKINS.

The crop of pumpkins shown on page 310 was grown by Mr. Anderson, of Bongamero, Cheshunt, the variety being the Mammoth.



CROP OF BROOM MILLET, CHESHUNT.

The plot was unmanured. Many of the individual pumpkins weigh over 80 lbs.; some of those shown are close to 100 lbs. The two standing



APPLE TREE ON MR. ANDERSON'S FARM, CHESHUNT.

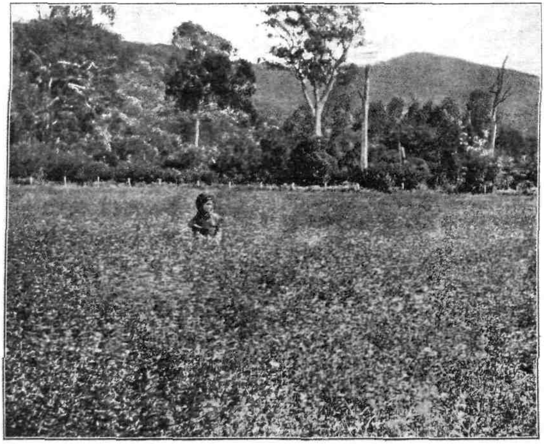
on end measure 3 ft. 6 in. in he'ght and 18 inches in diameter. Crops of 20 tons to the acre are not unusual, while it is one of the cheapest crops to grow and harvest known, and occasionally large quantities are sold to New South Wales buyers at high prices.

OTHER CROPS.

Other crops, such as arrowroot, chicory, beans, onions, flax, and sugar beet, have been grown for experimental purposes, and have all proved suitable to climate and soil, and in time will probably be grown largely for profit. Many fruits, including red, white, and black currants, do well; while apples, pears, plums, cherries, nuts, and other fruits grow luxuriantly. The apple tree photographed measures 46 feet across the width covered by branches, and yields over a ton in some seasons.

FODDER CROPS.

For the growth of maize, millets, amber cane, imphee, and artificial grasses the district is eminently suitable, and the cultivation of all of these is gradually increasing. Lucerne has proved hard to establish in some



MR. P. HOWARD'S LUCERNE FIELD, CHESHUNT.

cases, but has been successful in others, as the view of Mr. Howard's five-acre plot at Cheshunt shows. This crop is four years old, and has been cut twice this summer, giving a heavy crop of hay with each cutting. side, Golden Crown grass, *Paspalum dilitatum*, also thrives well, as do taken escues, Rye grass, clover—both white and red—and many other produ grasses. Japanese millet is now grown by many farmers with vidual be results, and is highly spoken of as feed for dairy cows in has sold han *tages, and makes a very fair hay with the last cutting in the* row.

IMPROVEMENT IN LATE YEARS.

A little more than 30 years ago this portion of the King River district was a cattle run, and homesteads were few and far between. The land was difficult to clear, being heavily timbered with red and white gum, the undergrowth consisting of dog-wood scrub, wattle, and bracken. The distance from a railway was 30 to 40 miles, with a bad road to traverse. However, since the advent of the narrow-gauge line some five years ago, the district has developed very fast, and it is now fairly closely settled. The Whitfield estate, purchased by the Government under the Closer Settlement Act, has been the means of placing many families on the land, there being now on the estate nearly 200 souls, where previously not more than ten existed, and many nice homesteads are now to be seen throughout the estate. The improvements made by the settlers during their four years' occupation, in clearing, fencing, building, &c., are very considerable, and, having overcome the initial cost of settling, it is to be expected that their results in the future will be good. They are now in a position to devote more of their time to cultivation, and by the more general use of ensilage, and attention to intense culture, their profits might be doubled.

MR. MACONACHIE'S HOUSE AND ORCHARD, WHITFIELD ESTATE.

It is gratifying to note the better class of cattle on the farms, as compared with past years, and the evidence of increased prosperity throughout the district. Good horses and vehicles are to be seen almost everywhere, and more comfortable houses than heretofore. The resources of the district are very great, and farming methods are gradually improving. Within the last twelve months at least five silos have been erected, and the use of chemical manures is becoming more understood and adopted. The prospects generally leave little to be desired. An important town in Wangaratta is growing fast, and, though the distance from the metropolis is 170 miles, the advantage of having a New South Wales market quite counterbalances such a handicap. Roads and climate are good, the price of land moderate, as compared with many other parts of Victoria, while the water supply is of the purest, and is abundant.

A prosperous co-operative butter company has creameries at intervals of 6 or 7 miles up and down the valley, and State schools are to be seen

in every direction. The past summer was a severe one, yet the crops generally are good, and, with irrigation and judicious management, failure would be almost impossible. The development during the past ten years is so marked that any thinking person must realize that great possibilities may be expected in the same period ahead.

THE ORCHARD.

James Lang, Harcourt.

The weather is unusually dry for the time of year, but good rains may fall at any time, and make it much easier to prepare the ground for planting. This work should be pushed on with as rapidly as circumstances will permit, so as to be ready next month. If the land requires draining, it should be done before the ground is planted. Drains should be not less than 2½ feet deep, and if tiles are used they should be from 2½ in. to 3 in. in diameter; 4-in. tiles should be used for main drains. If the land to be drained has rather a steep fall, the drains should run diagonally across the fall of the hill; by this means the water is cut off better than if the drains are run straight up and down the hill. Where stones are plentiful they may be used for the drains, but are liable to choke them up if the ground is sandy. Temporary drains may be made with brushwood; these will last a few years, and can then be replaced with tiles.

It is astonishing how few orchardists grow grape-vines even for home use. The excuse generally given is that they do not grow very well, but if varieties suitable for the district are planted, they would succeed moderately well, even in the cooler districts. A quarter of an acre of land would provide sufficient grapes for a good-sized family, and also a few cases to send to market. Early White Malvasia is one of the earliest varieties to ripen; it is small in bunch and berry, and is valuable only for its earliness. Chasselas comes next in order of ripening, and is a much superior grape to the variety previously mentioned. Blue Imperial or Ulliade, a dark oval grape, is also good. Black Hambro and Muscat Hambro are very fine varieties, Muscat Hambro being considered the best-flavoured grape in cultivation. The above-named varieties are all suitable kinds to grow in the cooler districts of the State, and always give a good supply of grapes. In the warmer parts of the State, such varieties as Waltham Cross, Red Prince, Centennial, Muscat of Alexandria, Madresfield Court Black Muscat, and Doradilla would succeed; these are all fine varieties, large in bunch and berry, and should be grown in the warmer districts only.

Take off Codlin Moth bandages from the trees, and scald them to destroy the larvæ which may be harboring in them. When dry, put the bandages away for use next season. It may be well, also, to scrape all loose bark where the grubs can get shelter. All possible means should be taken to reduce the number of the grubs.

Owing to the exceptionally dry season, Red Spider has been much in evidence, and will require to be dealt with before next season. Many orchards which have come under the notice of the writer have suffered very severely from this pest. Spraying the trees with kerosene emulsion is a good remedy.

If not already done, peas intended for green manuring of the orchard should be put in at once.

STATISTICS.

Rainfall in Victoria.

FIRST QUARTER, 1906.

TABLE showing average amount of rainfall in each of the 26 Basins or Regions constituting the State of Victoria for each month and the quarter, with corresponding monthly and quarterly averages for each basin deduced from all available records to date.

Basin.	January.		February.		March.		Total for First Quarter, 1906.	Average for First Quarter.
	Amount, 1906.	Average.	Amount, 1906.	Average.	Amount, 1906. *	Average.	*	
Glenelg and Wannon Rivers	0.13	1.51	0.80	0.77	2.31	1.55	3.24	3.83
Fitzroy, Eumerella, and Merri Rivers	0.32	1.64	1.01	0.89	1.84	1.82	3.17	4.35
Hopkins River and Mount Emu Creek	0.13	1.72	0.80	1.05	3.41	1.84	4.34	4.61
Mount Elephant and Lake Corangamite	0.16	1.79	0.55	1.16	2.55	1.86	3.26	4.81
Otway Forest	0.19	3.29	0.46	1.66	3.09	3.22	3.74	8.17
Moorabool and Barwon Rivers	0.11	1.57	0.51	1.22	4.03	1.55	4.65	4.34
Werribee and Saltwater Rivers	0.26	1.67	0.60	1.58	3.33	2.00	4.19	5.25
Yarra River and Dandenong Creek	0.39	2.79	0.72	1.70	3.94	2.44	5.05	6.93
Koo-wee-rup Swamp ..	0.39	2.71	0.50	1.39	3.49	2.21	4.38	6.31
South Gippsland ..	0.26	2.77	0.38	2.12	5.33	2.47	5.97	7.36
La Trobe and Thomson Rivers	0.31	3.05	0.54	1.92	5.49	2.33	6.34	7.30
Macallister and Avon Rivers	0.21	2.25	0.34	2.28	6.72	1.47	7.27	6.00
Mitchell River	0.23	2.79	0.18	2.94	6.64	1.49	7.05	7.22
Tambo and Nicholson Rivers	0.28	2.88	0.22	2.62	10.81	1.37	11.31	6.87
Snowy River	0.30	3.26	0.42	2.75	8.31	2.11	9.03	8.12
Murray River	0.02	1.31	1.00	1.37	4.78	1.68	5.80	4.36
Mitta Mitta and Kiewa Rivers	0.12	2.01	0.76	2.47	7.42	2.46	8.30	6.94
Ovens River	0.09	2.32	0.78	2.37	8.15	2.37	9.02	7.06
Goulburn River	0.07	1.49	0.81	1.29	2.88	1.65	3.76	4.43
Campaspe River	0.04	1.32	1.04	1.13	2.97	1.86	4.05	4.31
Loddon River	0.03	1.10	1.40	0.91	2.37	1.30	3.80	3.31
Avon and Richardson Rivers	0.03	0.92	0.53	0.69	2.18	0.96	2.74	2.57
Avoca River	0.01	0.91	0.65	0.67	2.04	1.17	2.70	2.75
Western Wimmera ..	0.09	0.99	0.47	0.52	1.93	0.94	2.[illegible]	2.45
Eastern Wimmera ..	0.06	1.25	0.82	0.66	1.99	1.18	2.87	3.09
Mallee Country	0.03	0.88	0.65	0.76	2.22	0.87	2.90	2.51
The whole State	0.12	1.67	0.70	1.32	3.76	1.58	4.58	4.57

* Figures in these columns are subject to alterations when the complete number of returns for March has been received.

P. BARACCHI,
Government Astronomer.

Perishable and Frozen Produce.

Quarters ended 31st March, 1906 and 1905 respectively.

Description of Produce.		Exports from the State.		Deliveries from the Government Cool Stores.	
		1906.	1905.	1906.	1905.
Butter ...	... lbs.	12,018,622	9,468,848	8,415,288	6,684,496
Cheese ...	... "	211,200	320,040	20,543	...
Milk and Cream	... cases	3,923	2,802	383	1,744
Ham and Bacon	... lbs.	729,520	429,360	...	...
Poultry ...	... head	15,570	11,885	4,109	3,855
Eggs... ...	... dozen	6,390	8,310	16,066	5,424
Rabbits and Hares	... pairs	1,037,364	1,135,272	508,474	471,377
Mutton and Lamb	carcasses	251,105	90,781	56,501	27,426
Beef	...quarters	2,598	1,291	...	350
Veal	carcasses	1,279	2,645	...	100
Pork	... "	2,456	322	844	315½
Fruit ...	... cases	66,182	66,832	541	1,995
" Pulp ...	... "	1,774	5,442	...	...
Sundries ...	... lbs.	...	...	10,123	55 429

R. CROWE,
Superintendent of Exports.

Fruit, Plants, Bulbs, Grain, &c.

Imports and Exports inspected during the Quarter ended 31st March, 1906.

Fruit, &c.	Imports.		Exports.		Fruit, &c.	Imports.		Exports.	
	Australasian.	Oversea.	Australasian.	Oversea.		Australasian.	Oversea.	Australasian.	Oversea.
Apples ...	224	2	1,312	32,797	Raspberries	33	—	—	—
Apricots ...	344	96	1,992	—	Tomatoes...	19,140	—	731	—
Bananas, b s.	119,415	—	—	—	Plants ...	22	125	28	—
Bananas, c s.	780	—	1,442	—	Bulbs ...	16	59	14	—
Black Currants	2,938	—	—	—	Barley ...	22,540	—	—	—
					Beans ...	95	30	—	—
Blackberries	461	—	2	—	Copra ...	—	187	—	—
Citrons ...	11	—	—	—	Currants ...	—	750	—	—
Cucumbers	3,048	—	284	—	Figs ...	—	150	—	—
Gooseberries	—	—	1	—	Nuts ...	630	387	—	—
Grapes ...	56	—	394	50	Nutmegs ...	—	123	—	—
Lemons ...	3,142	9,691	535	—	Oats ...	6,585	—	—	—
Melons ...	1,141	—	77	—	Oil-cake ...	—	12,008	—	—
Mixed fruits	181	152	7	—	Onions ...	—	241	—	—
Nectarines	—	—	192	—	Peas ...	—	1,195	—	—
Oranges ...	1,123	6,059	101	—	Potatoes ...	975	11	—	—
Passion fruit	374	—	88	—	Rice ...	—	52,690	—	—
Peaches ...	—	—	1,831	61	Seeds ...	7,401	2,864	—	—
Pears ...	50	—	4,603	1,904	Wheat ...	—	—	—	—
Persimmons	254	—	—	—	Yams ..	—	172	—	—
Pineapples	26,919	—	787	—					
Plums ...	14	—	2,637	—					
Quinces ...	—	—	5	—	Totals ...	217,912	86,992	17,063	34,812

J. G. TURNER,
Inspector, Vegetation Diseases Acts, and Exported Products Act.

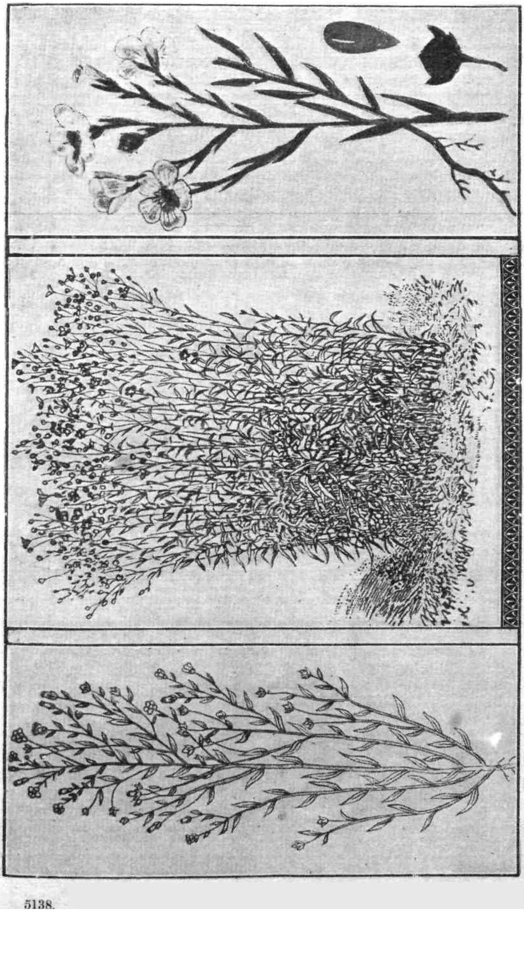


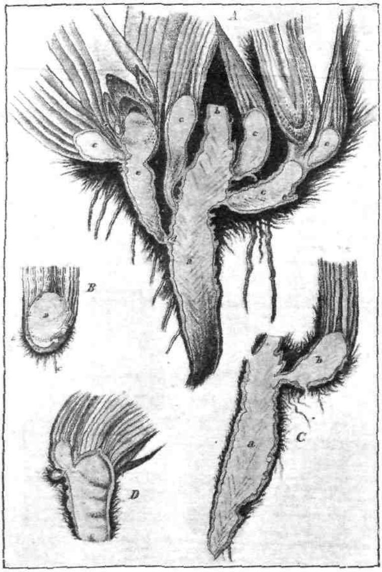
Fig. 1.—Flax Grown for Seed.

Fig. 2.—Flax for Fibre.

Fig. 3.—Flax Plant.

FLAX PLANT (LINUM USITATISSIMUM).

The accompanying plate shows the sections of the root-stalk of the *Phormium*, illustrating the mode of growth and propagation:—A. Section of compound rhizome, or prostrate stem, of *Phormium tenax*, showing (*a*) main axis, or central stem, from which a flower-stalk (the terminal axis of the plant) has been given off at *b*, *c*; lateral shoots forming new leaf-buds; and, ultimately, fans that accumulate nourishment at the base of their leaves, throw out rootlets, and finally become independent of the



STRUCTURE OF ROOT OF PHORMIUM TENAX.

parent leaf, as at *d*; (*e*) first stage of buds from which lateral roots spring. B. Section of root of *Phormium tenax* in best condition for transplanting, showing—(*a*) Mass of fibrous, starchy, and resinous matter accumulated for the nourishment of the future flower-stalk and lateral buds; (*b*) cortex layer, formed from the bases of the old leaves; (*c*) rootlets. C. Underground stem of manunu (one of the best varieties of *Phormium tenax*), showing—(*a*) Main axis that has flowered and completed its life; (*b*) lateral shoot by which the life of the plant is continued.

Class of Soil Suitable.

It would be difficult to say what soil this hardy plant will not thrive in, but there are certain conditions which it must have to be successful. There is one in particular—that is sufficient moisture. It does not mean, as is generally supposed, that it wants a swamp, or a running stream, but a humid climate, so as to assure a constant and steady growth. In the dry, arid districts it will be found thriving well along the water channels, and where the soil is free it makes wonderful growth.

Much depends on the variety planted. The late Baron von Mueller describes both hill and swamp varieties. Sir James Hector mentions, in the publication previously referred to, 50 varieties which are recognised by the natives, but it is questionable whether many of these are not the same, or at least "sports" or hybrids, as must be the case when plants are grown together, and springing up from seed dropped. There is also in the work referred to an account of 25 acres being planted by the "Patea Flax Company," in which the number of varieties selected consisted of six, described as follows:—

Oue ...	...	Red edge
Atiraukawa	...	Light; bronze edge
Korako	...	Black edge, light colour in leaf
Huhiroa	...	Black; narrow edge
Atewheke	...	Scarlet edge
Tihore	...	Orange edge and keel.

Unfortunately, whilst giving the names of varieties, they do not describe the class of land planted. To plant the hill varieties in low-lying land, or swamp varieties on the hills, would be a mistake.

Varieties should be selected to suit the soil and other conditions. My experience leads me to say that on the light-red chocolate soil in our highlands, where the rainfall is good, any of the hill varieties will make a growth fully equal to any described.

The same applies to light sandy or loamy soil where there is sufficient moisture, with drainage. The so-called swamp varieties will do well in a situation such as the banks of a running stream, or where the land is occasionally flooded, but will not thrive in low, stagnant pools. The best growth is made in reclaimed swamps, or where the swamp has been partly drained to the depth of 1 foot or so.

It cannot be too strongly impressed on the minds of those about to plant that the soil and the variety must be considered. There should be no difficulty in getting soil to suit the class of plants available. There are large tracts of country along the coast, portion of it covered with cut grass, and useless for any purpose. Much of this land, with proper treatment, would produce flax in abundance. This was recommended by the late Baron von Mueller over 40 years ago, when distributing plants, &c., from the Botanica Gardens.

Phormium tenax is one of the most hardy plants introduced, and there is no difficulty in finding suitable soil in most parts of the State.

Propagation.

There are two methods by which plants may be provided, namely "seedlings" and "division of roots." The division of roots, or stools is that generally recognised as being the best.

The illustration on page 354, copied from Sir James Hector's work, shows the root system of the plant, and sets forth at a glance how the divisions are to be made. A well-grown plant will give from 50 to 100 sets, and by careful selection the best quality of plants could be secured. This is most important to those about to plant in this State, as it is generally recognised in New Zealand that only a portion of the plants growing are of sufficient value, from a fibre-producing point of view, for the labour incurred in its extraction.

When planting from one set, as described above, none but such plants as are approved of should be set out. The testing of a leaf or so of each plant is extremely simple, and need not be referred to here; but if this precaution is taken, as I have already stated, nothing but suitable plants will be selected.

BED OF SEEDLINGS TWO YEARS OLD.

The second system is raising plants by seed. This takes a much longer time in bringing plants to maturity. Whilst it may be considered a reasonable thing to expect a cutting in a plantation when from three to four years old, it would take much longer with seedling plants.

The above illustration shows a bed of seedlings two years old, grown by the officer in charge of the gardens of the City Corporation, on the banks of the Yarra. His method of raising is simple, but effective. The seeds are sown in boxes; when they reach a certain stage they are potted out, and after remaining some time they are set out in beds, as shown in the illustration. As these plants are raised for ornamental purposes only, the methods adopted by him will not answer so far as selection is concerned.

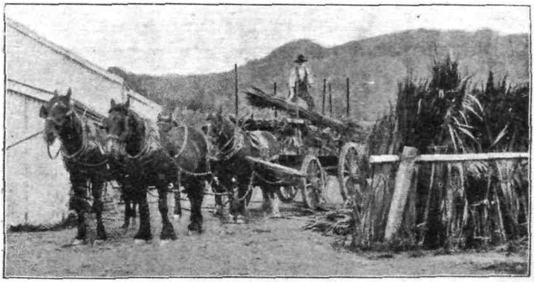
It is well understood that when a number of plants of the same variety are grown together that the flowers become hybridized, and that the seedling cannot be regarded as characteristic of the parent. No doubt, it is a

much less expensive way to secure plants; but where, as in this case, a plantation is made for almost all time, it will repay the selection of plants when planting.

To those who have isolated plants growing, and these of sufficient merit to warrant their use, the seeds may be used with safety; but where there is any chance of the plants becoming as described above, it would be unwise to adopt this course. I regret to say that in New Zealand, where this industry flourishes to such a large extent, very little attention is given to the selection of plants; although it takes a certain number of tons to produce a ton of fibre, it is recognised that by selection and cultivation the same weight of leaves will yield twice the amount of fibre. I cannot help thinking that in the establishment of an industry of this kind it is imperative that a thorough investigation should be made into the character and condition of the plants about to be set out.

METHOD OF PLANTING.

There is nothing to guide us in this respect so far as plantations are concerned. The crops of *Phormium tenax* are generally self-sown, and in



ARRIVAL OF GREEN LEAF.

their natural state grow without cultivation, but the principle is similar to various other plantations which have to be worked by manual labour. The character of the soil will have much to do with distance and other arrangement. The plants, when full grown, spread out, covering from 4 to 6 feet in width, and whilst they would be kept in check to a certain extent by an annual cutting, the planting would necessitate allowing sufficient room for the plants to develop thoroughly.

The plantation of the Patea Flax Company, referred to previously, was set out in rows 6 feet apart, and plants standing 6 feet between each other in the rows; but it is quite clear that where the land is suitable, and other conditions favorable, that the ground would be completely covered, and the plants become stunted from want of nourishment. If an additional two or three feet were left between the rows, it would allow for the working generally of the plantation.

It must be borne in mind that there is a great bulk of material to be taken from a plantation. The yield is said to be from 12 to 18 tons per

acre, and to get this away it would be necessary to have roadways, as in vineyards, say, every ten rows, to gather up the bundles of leaves.

The previous illustration is taken from a New Zealand report on flax. It shows the haulage on the wheels. It will be easily seen that it would also be advisable to leave plenty of room for the vehicles to pass, or in many cases the plants would be damaged. The practice in New Zealand amongst the natives is to plant two or three sets in a hole. By this means, no doubt, an earlier return is secured, but it is questionable if the practice is advisable. When plants are somewhat difficult to get, it would be preferable to put in single plants, as their growth is rapid under favorable conditions, and in a short time the ground would be fully occupied. The set or sets are placed in a shallow hole, and the fibrous roots spread out when the earth is well tramped down. The depth of planting should not be more than three to four inches below the surface. The outside leaves should be cut back, but not the inner ones. This will enable the plant to become firmly established, when it will make a vigorous and healthy growth.

The advantages of a little care in planting, where both lines are kept, would considerably facilitate the after working. Phormium plants readily respond to thorough cultivation, especially in the earlier stages of their growth. In the case of planting trees, vines, &c., it is a great advantage to be able to cross-cultivate, and thereby keep the land in proper tilth. The wisdom of this has been generally recognised by orchardists and vignerons.

TIME OF PLANTING.

The most suitable season for planting is autumn, but when that is not convenient early spring may be adopted. With autumn planting, the sets become established by the heat retained in the soil, and will pass the winter over without suffering. Such plants may be also said to save a season's growth, as they are able to take advantage of the full spring season. But spring growth will answer equally well so far as the establishment of the plant is concerned.

The plant is an extremely hardy one, and will adapt itself to conditions where other plants would perish. In the establishment of an undertaking like this, it is advisable, where practicable, to have the soil thoroughly in order, and to plant out in early autumn.

GATHERING THE LEAF.

The plant consists of a number of shoots clustered together, each shoot producing a quantity of leaves, which strike up from the centre. The outside leaves, when not gathered, wither and die, and are of little value for fibre; but, when gathered annually, they are cut off near the bottom, leaving two or three centre ones uncut. It is stated that those who adopt this system gather an annual crop from the same plants, and the plant itself makes a much more rapid growth. This is reasonable, as it is well known that any plant deprived of its foliage is checked in its growth for some time. But this system is not universally adopted; in some cases the whole plant is cut off at one time, centre leaves and all. These are sorted, or graded, at the mill before treatment.

Where there is a plantation which has been carefully planted out, it is well worth taking every care in preserving it; and by cutting the outside leaves of each shoot, and leaving the three centre ones, less check will be given to the growth, and an annual gathering will be secured. The

leaves should be cut off just below where the green portion terminates, as the soft, thick parts do not work up well with the other portion of the leaf, and have to be recut at the mill before treatment. These, when cut, are bound up into sheaves of a size convenient to handle, and are carted to the mill, where they are sorted out ready for treatment.

THE YIELD.

The officials of the Department of Agriculture, New Zealand, state that, from uncultivated land, from 12 to 18 tons of green leaves per acre are gathered, but from a properly planted and cultivated plantation, according to experiments made, upwards of 50 tons could be gathered, and that the yield of fibre from carefully selected plants would be greater. According to the experience of various mills in New Zealand, it takes from 5½ to 6 tons of green leaves to make one of fibre.

There are various methods adopted in New Zealand of gathering leaves. It is usually from private land that they are obtained, and the owners claim a royalty; in some cases 12s. per ton is paid for the leaves as they are carted to the mill. The cost of cutting and binding is from 10s. to 12s. per ton. In some parts, where the mills are worked in the close vicinity of navigable streams, the green leaf is delivered at a cost of from 20s. to 25s. per ton.

If the yield of leaves is 12 tons per acre, this will give two tons of dressed fibre at £20 per ton	£40	0	0
Cost of leaves delivered at mill—12 tons at 22s. 6d. per ton	13	10	0
	£26	10	0

EXTRACTING FIBRE.

There are two methods of treating this product to extract the fibre—one by machinery, and the other by chemicals and machinery. The latter method has not been used to any extent, but is spoken well of by various writers. That the fibre can be extracted has been proved by me on various occasions. A firm in the city which has taken up the treatment of the Linum flax has produced good samples of fibre from the *Phormium tenax.* But the principal method of extracting the fibre is by machinery, and quite a number of various designs are in use in New Zealand. Most of these do good work. Recently the New Zealand Government gave a bonus for the encouragement of an improved machine, and considerable competition took place.

The commission appointed to examine into the merits of the various competitors have set forth the particulars of each in their report to the Hon. Minister of Agriculture, which is published in pamphlet form and distributed. This is interesting reading to those who contemplate dealing in any way with Phormium. As to the cost of machinery, much depends on the amount to be treated. Some mills are put up to produce several tons of fibre in the week, whilst others aim at smaller productions.

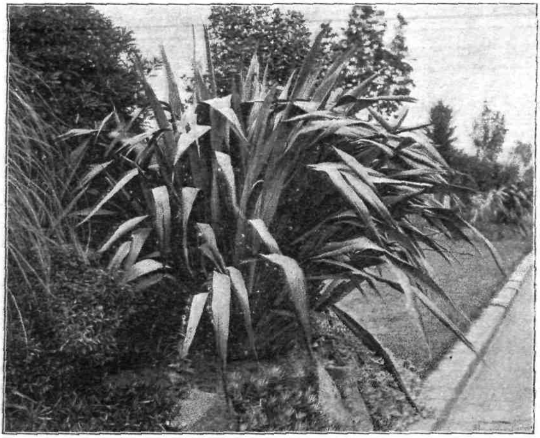
The power employed is an important item in giving the cost of a "treating plant." One capable of producing, say, one ton or so of fibre per week may be set down at from £150 to £200; this is complete, without the power. There are, according to an official publication, about 400 mills at work in New Zealand. Some are worked by water power, others by steam, but little can be said of the machinery from the information at present available.

From the experience gained in dealing with the production of the Linum flax, one of the most important features is to show that there is machinery available for its treatment when produced.

VARIETIES.

The following descriptions are taken from Sir James Hector's work:—

"*Harakeke* (Common Swamp Flax).—Leaves coarse, loose, drooping, points generally blunt; flower-stalk large, 11 feet to 14 feet high, and 1 inch to 2 inches in diameter; pod, short, erect. Grows almost everywhere, but attains its largest size (14 feet to 15 feet) on rich alluvial soil, by banks of streams. Many sub-varieties are found, some with dark blue-green leaves above and glaucous below, and some pale olive-green, or bronzy.



COMMON SWAMP FLAX.

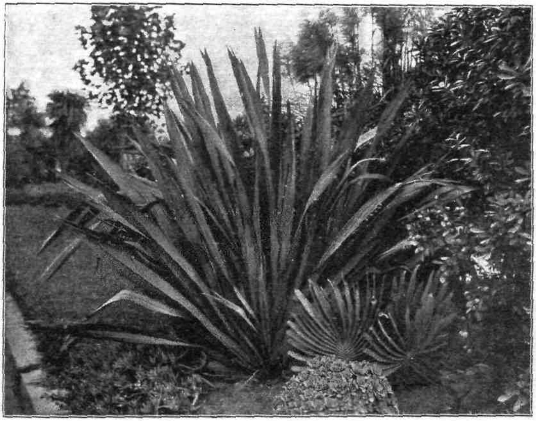
Some varieties have also the butts of the leaves coloured with red for some distance up, while others are yellowish-green almost to the very base. When the plant is stunted, the flower-stalk is also small, and the best characteristic is the blunt point to the leaf.

Paretaniwha (Yellow Hill Flax).—Leaves erect, slightly drooping at the tip, yellowish-green, generally with red or orange margins, slightly glaucous below, point acute; flower-stalk small, 4 feet to 8 feet high, and ½ inch to 1 inch in diameter; pod, short, erect; fibre very good, soft and glossy. Plant seldom more than 5 feet or 6 feet in height; grows generally on clay hills.

Tihore.—Leaves stiff, erect, narrow, never drooping at the tip, olive-green, glaucous below; points very acute, or cupsidate, pink at the butt;

flower-stalk, 9 feet to 10 feet high, and 1 inch in diameter; pod, erect or inclined. Seldom flowers, and still more rarely seeds. Plants seldom over 6 feet in height. Grows in rich, dry, alluvial land; never in swampy places. I have never seen it except where planted by the Maoris. I have here applied the name to that variety called "Tihore" by the Maoris throughout the Waikato, and which is probably identical with the "Oue" and "Tapato." It is best distinguished by its narrow, tapering, sharp-pointed leaves and erect, close habit. It grows so thickly together that I obtained 186 sets for planting from two bushes.

Phormium tenax that grows on high or dry ground, though smaller, is in general finer and more easily stripped than that found in swamps. Colonial rope-spinners prefer it, and are willing to give a higher price for it on this account."



HILL FLAX.

The above descriptions are somewhat difficult to follow, as far as identification is concerned. Unfortunately, no care has been taken to retain the names of the varieties introduced here. They have been planted indiscriminately, as they are for scenic effect only.

The illustrations show the variations in the system of growth. They represent plants growing on the St. Kilda road, which were planted by the City Corporation. No. 1 shows the drooping habit, and coarse leaves referred to above, and, no doubt, if it were growing in its natural habitation, namely, on the water's edge, these features would be much more pronounced. No. 2 is typical of the hill variety, being erect, and hardier in its appearance. There are two varieties of variegated flax, but as to their value for fibre production little is known of them here.

PROFITABLE NATURE OF THE INDUSTRY.

The Minister for Agriculture, the Hon. George Swinburne, M.L.A., when visiting New Zealand recently, gave this matter attention. He gives an instance of one land proprietor receiving £9 per acre as royalty for the privilege of cutting leaves from his land. One instance is given in Sir James Hector's publication of 12s. per ton being paid as royalty for green leaves, so that, at the rate of 12s. per ton, and taking the yield at 15 tons per acre, this would give a return of £9.

These figures, possibly, are exceptional. Many instances are recorded of good returns being obtained from the yield of leaves without any effort on the part of the proprietor, and, with proper care in selecting the best varieties in planting, equal or better results could be obtained here.

The value of this industry may be estimated by the latest returns published of the imports of fibre and cordage into Victoria:—

Fibre, from all sources	£79,266
Cordage, binder twine, &c.	41,941
Total	£121,207

The exports of *Phormium tenax* from New Zealand totalled £730,803, of which the imports to Victoria of fibre amounted to £25,590, and of cordage and twine to £5,929. The average price of fibre exported from New Zealand during 1905 was £25 17s. 6d. per ton.

CONCLUSION.

In advocating the cultivation of this valuable fibre-producing plant, I feel confident that there is a great future for it, as the growing demand for this class of fibre is considerable. Binder twine alone would justify it being taken up in this State. But every care should be exercised in entering upon this industry, and none but the right class of plants secured, as a mistake in this respect would seriously retard its development.

Large tracts of suitable land are available for this purpose, and, beyond preparing, fencing, and planting, nothing further is needed, except an occasional stirring of the soil. Many of our capitalists, no doubt, would be prepared to take this matter up, if encouraged by some special condition by way of securing land for the purpose. The inquiries for information concerning this matter lead me to believe that something will be done in the way of planting before long, and it would be a mistake to neglect the best advice and assistance available.

THE ORCHARD.

James Lang, Harcourt.

Where the extension of existing orchards, or the planting of new orchards, is contemplated, the work should be taken in hand at once, as ccne seasonable rains which have fallen all over the State have put the ½ inund in a fit condition for planting operations. In selecting the varieties glossyruits to plant, growers should confine themselves to those varieties rally on succeed best in existing orchards in their respective districts. The *Tihoret* always knows the varieties which succeed best with him, and green, glaucrdingly, but where new orchards are being planted the beginner

may not have that experience, and it would, therefore, be well for him to consult some careful orchardist in his district as to the most suitable varieties of the different fruits to plant.

In planting apple trees, the first consideration should be given to those varieties which are most suitable for export, as the supply of apples for local consumption has now overtaken the demand. Any extension in apple planting should be in the direction of supplying oversea markets. The varieties enumerated are good export apples.

The most popular apple at the present time with the majority of growers, either for export or local market, is the Jonathan. This is a splendidly coloured apple, and of good flavour. The tree is only a moderate grower, however, and as a rule does not grow to a very large size; in some districts the complaint is that it only makes a weakly growth, and soon becomes unprofitable; but in districts where it grows well it should be largely planted. Many of our leading orchardists consider it the most profitable apple to grow. Cleopatra does best in the warmer districts of the State, such as the Goulburn Valley. Growers around Melbourne say that it does not do well with them now, being much subject to the scab—(*Fusicladium dentriticum*). If well sprayed in the spring time with Bordeaux mixture, the fruit would be fairly clean. Where this variety succeeds, it is a most profitable kind to grow; the writer has picked and packed for export eighteen cases from one tree in his orchard. It is also largely grown in South Australia, and is the favorite there with shippers.

Munroe's Favorite is a fine variety. It succeeds well in most districts of the State, and is also a favorite with the London buyers, good samples always bringing top prices. The tree is a strong grower, and soon grows to a good size. It is also a most prolific bearer; an orchard planted with this variety would, in the opinion of the writer, give a better return than any other single variety of apple. Dumelow's Seedling, or Wellington Pippin, is ready for shipping early in the season—*i.e.*, during the month of February. Esopus Spitzenberg is a first-class apple, of fine appearance and good flavour. The tree is a good grower and a prolific bearer.

Sturmer Pippin matures late, and should be sent in the later shipments. This variety is largely grown for export in Tasmania. Rome Beauty is also a good apple for export, and does well in most districts of the State.

London Pippin does not seem to take so well now as it did a few years ago. Large samples of this variety should not be shipped; medium size carry much better. Newtown Pippin is one of the very best varieties, being one of the best-flavoured apples grown. This is one of the leading varieties of apples shipped from America, and commands top prices in the market. It has not hitherto been very largely shipped by Victorian orchardists, but is worthy of extensive planting in districts where the trees do well. Rymer is now being shipped in quantities; it does not seem, however, to take the market so well as the others mentioned.

The varieties mentioned have proved themselves the most suitable for export, and growers who confine their shipments to them will have a good average price at the end of the season. It is far better, and more profitable for orchardists, to grow and export only the varieties which have already made a name in Covent Garden Market than grow those which are not known there.

Citrus fruits should not now be planted, but the trees held over till the early spring, when the temperature is a little warmer.

DISEASES OF FARM ANIMALS.

S. S. Cameron, M.R.C.V.S.

IV.—PREVENTION OF DISEASE.

Breeding—Feeding—Watering—Management—Cleanliness—Disinfection: Fire; Chemical Agents, Fumigation; Physical Agents, Heat, Cold, Dryness, Insolation (sunlight); Mechanical Agents, Filtration, Sedimentation, Ventilation, Perflation, Internal Disinfection, Inhalation—Disinfection of Premises—Disposal of Dead Animals—Isolation—Immunity: Inherited, Naturally Acquired, Artificially Acquired, Virus Inoculation, Anti-toxin Inoculation—Immunity Table.

Just as there are certain circumstances and conditions of body and of environment which tend to the acquirement of disease, so there are certain factors which make for healthfulness, and which, when exerted to the full, have powerful influence in warding off attacks of disease or in mitigating their severity. By the general and continuous practice of hygienic principles and the adoption of methods of adequate sanitary efficiency both the avoidance of predisposing causes and the mitigation of the more marked effects of exciting causes may be compassed.

For the prevention of outbreaks of specific diseases, and of their spread, means special to the disease are adopted. The character of these means will depend largely on an understanding of the nature of the disease, its incubative period, its mode of spread, and other like special features, and will moreover be conditioned in some cases by local circumstances and commercial considerations. They will also depend on the existence of special legislative enactments, and machinery and facilities for administering such. To some extent preventive measures will be indicated in later chapters, when the diseases to which they apply are being dealt with. In this place it will suffice to give short consideration to some of the more important of the many factors which make for general good health and for lessened susceptibility to disease.

BREEDING.

Care in the selection and mating of breeding stock is necessary for the prevention of those diseases which are generally regarded as hereditary. (See page 269.) The breeding from tuberculous cows may, under circumstances specially arranged, be so conditioned that little, if any, risk of the disease being transmitted is run; but under ordinary circumstances the risk of transmission in breeding from tuberculous sires and dams is a large one, and should be unhesitatingly avoided.

Horses affected with any of the following diseases or unsoundnesses should not be used for breeding purposes:—Nasal disease (osteoporosis), rheumatism, ricketts, roaring, whistling, broken-wind, grease, navicular disease, ringbone, bone spavin, bog spavin, thoroughpin, curb, and cataract. It would be well, too, if breeding from stock possessing radical defects of conformation was avoided—such as, particularly, those with calf-knees, bent legs, round gummy joints, flat feet with weak "corny" heels, narrow contracted heels and muley feet, sickle hocks, knuckled fetlocks and long weak pasterns; those "tied in" below the knee and hock, and those which [illegible] "brush" or "speedy cut."

The supineness of Australian horse breeders generally, and particularly [illegible] who have the management of stock shows and stallion parades, in [illegible] to the question of transmissible unsoundness in breeding stock, is

remarkable. It is apparently begotten of that carelessness in the selection of sires and dams which was engendered in the days when horse flesh was a drug in the market. But in these present days, when ordinary sizeable three or four-year-old draught colts commonly fetch £40 to £50, and harness horses are proportionately valuable, it is surely little short of a scandal that prizes are commonly awarded at agricultural shows, which are supposed to exist for the *improvement* of agriculture and stock, to sound and unsound breeding stock indiscriminately. Instances are not wanting, even at the show of the leading agricultural society in this State, in which the blue ribbon has been carried off by an obviously unsound animal, and at some of the provincial shows the awarding of prizes to veritable "crocks" is an occurrence so common as to excite little or no comment. The judges are apt to shelter themselves behind the plea that they are not there to judge of unsoundness, but to be guided by make and shape and suitability only; but surely, in the case of breeding stock, the existence of, say, a spavin or roaring claims consideration under the heading of suitability for the purpose for which the exhibit is intended—viz., the begetting of sound and saleable progeny. At any rate, when, as happened at a leading provincial show in Victoria a short time back, of six horses awarded prizes in two breeding classes, four of them were palpably unsound, the spavin of the first prize thoroughbred and the curb of the first prize draught being distinctly discernible from the ring side, the judges cannot reasonably be acquitted of the charge of abetting in the deception of the breeders of the districts in which the ticketed champions are to be used. Equally culpable were the judges at a recent "National" show, who awarded first to a pronounced roarer, whose "music" could be distinctly heard while he was undergoing the not-too-wind-distressing ordeal of being judged.[1] Such happenings are almost incredible, and are calculated to excite amongst thoughtful men grave apprehension for the future of the horse industry.[2] Ask Indian buyers of extensive experience, or those who were intrusted with the buying of horses for South Africa during the war, as to the numbers of otherwise useful horses that are rejected on account of transmitted unsoundness, and say: Is it not time that prizes, by the gaining of which the average small breeder judges of the merits of the animal, should be awarded only to animals *worthy* of the distinction in *all* respects?

FEEDING.

The most essential attribute of food, in so far as it may be a factor in the maintenance of health, is that it should be sound. Sour milk in the production of diarrhœa in calves, musty hay inducing broken wind in horses, and fermented grains giving rise to indigestion and hoven in cattle, are familiar instances of the ill effects of unsound or decomposing food.

Next to soundness comes the necessity for regularity in feeding, and that the food should be in proper proportion, both as regards quantity and

[1] Apart from the question of hereditary unsoundness, but merely as proof of all-round carelessness in such matters, it may be mentioned that in two successive years at the Royal Show, Melbourne, the winners of Hunter's Plates were palpably unsound "for the purpose for which they were intended"—one had a pronounced bowed tendon, and the other was blind in one eye!

[2] I believe it is true of Australia as a whole, as it certainly is of Victoria, that at no show is the awarding of prizes subject to the condition that the selected exhibits should successfully withstand a veterinary examination for soundness; as is the common practice at leading shows throughout England, to wit:—The Royal, the Bath and West of England, the shows of the Hackney and Hunter's Improvement Societies, and at Islington, and has been recently made the practice in New Zealand. Many of the Australian shows are subsidized by the State, but the condition that Government money or prizes should only be awarded to sound stock has never been imposed.

quality. By the observance of regular hours for feeding animals, and regular and not too prolonged intervals between feeding, a rhythmical action of the digestive organs is engendered, which induces more perfect digestion and makes for disease-resisting strength.

As a general rule, for all herbivorous animals, the advice to feed little and often is good, in that it is in accord with the method of feeding in a state of nature. When such practice is adopted with stabled animals, there is less likelihood of any food being left over, and consequently the tendency to stomach and bowel troubles resulting from the ingestion at next feeding time of soured or fermented food is minimized. Soiled food should always be removed after feeding, and should never be mixed with fresh feed. Complete mastication of the food is necessary to perfect digestion, and in the case of animals with the habit of "bolting" their food it is advantageous to let it be coarser than usual, so that chewing and grinding may be assured.

WATERING.

Very diverse views are held as to the proper time at which animals should be allowed to drink—whether before or after feeding. The most natural plan is to always have water accessible to the animal when in the stable. If this is done, as much water will be taken as is required, and no more, and it will be taken when required, and at no other time. The opinion that water should be given only in limited quantities—limited, too, according to the judgment of *man*—is an error. Animals in health seldom or never take more than they require. It is conceivable that, after long, enforced abstinence, or after profuse perspiration, they require—and take—more than is good for them to take at one drinking—a quantity, indeed, which will, by its volume of coldness, produce stomach or intestinal spasm (colic). In such circumstances it is advisable to interrupt the drinking for a time, or to take the "chill" off the water by warming it slightly, or by adding a little warm water to it. It is well that water should be withheld for some time prior to the imposing of violent exercise or work. Racehorses, for example, should not be allowed water in any considerable quantity during the three or four hours preceding a race. Perhaps the only other time when it is inadvisable to allow a long drink, if it is desired by the animal, is immediately after feeding, when the fluid, passing rapidly through the stomach towards its natural receptacle—(the *cæcum*, or blind gut, or water gut)—is likely to carry with it into the small intestines some of the stomach contents, which are still crude and harsh and not in a sufficiently digested state to pass on, and which, therefore, may irritate the mucous lining of the bowels to an extent sufficient to set up colic, or even inflammation of the bowels (enteritis). For similar reasons, if water is not kept continuously within reach, in which case, as previously stated, as much as will do harm will never be taken, the watering should always be done *before* feeding.

The obviousness of the necessity that drinking water for animals should be pure and wholesome has been previously indicated, when the part it plays in the causation of disease was dealt with. (See page 271.) To insure this, it is often desirable that purification by filtering through natural or artificially-constructed filter-beds, or by precipitating, or some other method of purifying should be resorted to; and the expense and trouble of establishing such precautions will be amply repaid

by the assurance which they afford of the continued health and vigour of the stock. On farms where the water supply consists only of water-holes, which become foul and fœtid from pollution by animal discharges, water troughs supplied by windmill should be provided. The objection is sometimes raised that, where water-holes and swampy patches are numerous, it is of no use providing drinking troughs, as stock will not make use of them; but it will be found *on trial* that stock will always go naturally to clean water. In point of fact, cattle may be frequently observed to refuse, or drink but sparingly of, contaminated water. They may be seen to go to a foul and slimy water-hole, stir the water by wading, then smell it, and drink a little, or wade out without drinking at all. That their thirst is not assuaged is evidenced by the fact that they may be seen to return and repeat the performance time and again. In any case, the fencing off of the water-holes or swamps would be a distinctly profitable undertaking if only as a safeguard against fluke and other such parasites.

MANAGEMENT.

So far as the prevention of disease is concerned, good management includes the continuous provision for housed animals of comfortable quarters and bedding, an adequate supply and interchange of fresh, wholesome air without the occurrence of draughts, suitable clothing, efficient grooming and cleaning, and regular exercise or work in moderation; and for animals in the paddock, in addition to an adequate supply of food and water, shelter, or protection by rugs from wind, rain, and insects and shade from the sun. It will be found, by careful observations over a longer or shorter period of time, that the measure of health or freedom from disease of any stud of animals is in ratio to the amount of care exercised in regard to these items of management.

There are certain times at which extra care in the management of stock is necessary and profitable. Young stock, particularly foals and calves, should be kept growing during their first winter. It is the worst possible policy to let them get low in condition, either from shortness of food or lack of protection from the weather. An ideal winter paddock for young stock should contain a straw stack, whereby both shelter and a picking of dry food is afforded. A check received during the first year is seldom made up for, and it will go hard with under-conditioned youngsters if anything in the nature of contagious disease gets amongst them. Weaning time is also a critical period. Foals should be gradually accustomed to take a little good, hard feed for some time before they are removed from their dams, otherwise the sudden loss of milk will be severely felt.

CLEANLINESS.

Although, perhaps strictly, this should have been included along with management, cleanliness is so much a thing apart in importance from all other factors in the prevention of disease that the strong emphasis of separate consideration is incumbent.

Cleanliness means, simply and essentially, the absence of germs and the lack of means for their multiplication and development. Diseases caused by germs make little headway where cleanliness in all things prevails. Take swine fever, essentially a germ disease, and mark the general experience that, amongst filthily-kept pigs, with rotten food to eat, foul

fluids to drink, reeking air to breathe, and a stinking stye with a filthy floor to lie in, the disease spreads like wildfire, and is proportionately fatal; whilst amongst paddocked pigs, or those attended to wholesomely, and fed on uncontaminated food, in frequently flushed styes, it appears to be almost non-contagious. Similarly with abortion in cattle, strangles in horses, and distemper in dogs, the associated fatalities and "catchingness" are always decreasingly proportionate to the cleanliness of the surroundings.

There is not much more to be said—in fact, nothing more need be said, if the fact has been impressed that cleanliness in all things connected with animals—in their surroundings, their feeding and watering, their housing and paddocking, when working and when at rest—is above and beyond all things the most important factor in the preservation of health and the vigorous resistance of disease, and that it is the essential feature in the subjugation of the spread of infectious and contagious diseases, and of the germs which cause them.

DISINFECTION.

Disinfection is the act or process by which infectious matter is removed or destroyed, and *disinfectants* are the agents used by which such removal or destruction is accomplished.

Fire is the most effective of all disinfectants, and it is taken advantage of in controlling the spread of communicable disease by the burning of carcasses and discharges of affected animals, and of sheds, bedding, manure, litter, soil and like substances with which such animals may have been in contact, or may in any way have infected or contaminated. Fire and heat are also used for sterilizing utensils and instruments, and for purifying water and milk by boiling. Disinfection by boiling, or by exposure to superheated steam or hot dry air is also commonly practised.

Next after fire in effectiveness come various *chemical agents*, the most powerful of which are corrosive sublimate (perchloride of mercury); sulphuric acid and other mineral acids; caustic potash, quicklime, and other strong alkalies; carbolic acid, lysol, creolin, and allied coal-tar products such as phenyle, Jeye's fluid, and Macdougall's dip; permanganate of potash (Condy's fluid); formic aldehyde (formalin); chloride of zinc (Burnett's fluid); sulphur vapour, and chlorine gas. Most of these act by coagulating or chemically combining with the albumen of which the infective germs are constituted, and so destroying them; and, *if they come in contact* with the infective matter, they are as effective as fire. Some of them are powerful caustics, and need to be used with very great care, and diluted to various strengths. Corrosive sublimate is usually diluted to 1 in 1,000 of water (acidulated), carbolic acid 1 in 20, formalin 1 in 40, permanganate 1 in 100, and they are safe and effective in these strengths. The first-named ought not to be used in disinfecting iron, tin, zinc, or leaden utensils, instruments, or materials, as it chemically corrodes these metals. Caustic potash and the milder carbonates of potash of soda have a solvent action on greasy matters, and are hence useful disinfectants in creameries, butter factories, and slaughter-houses. Another property which dictates their general usage at such like premises is their freedom from smell. Carbolic acid, chloride of lime, formalin, and other substances having a powerful and penetrating odour should not be used where food materials, and especially milk and its products, are being manufactured, prepared or stored. Quicklime, in the form of lime-wash and as a powder,

has been largely used, and is in great favour as a disinfectant of sheds, floors, ground surfaces, cesspits, and the like; but its efficacy as a destroyer of disease-producing germs is doubtless largely problematical, and when used as a lime-wash it is always a safe precaution to strengthen it with an effective proportion of carbolic acid, permanganate of potash, or other reliable disinfectant.

Experiments recently carried out by Mr. J. A. Gilruth, M.R.C.V.S., the chief of the New Zealand Government veterinary staff, would appear to indicate that lime is useless as a reliable disinfectant for bones, soils, and paddock surfaces in such diseases as anthrax. He mixed crushed bones known to contain spores with an equal quantity by weight of quicklime by grinding them together in a mortar. Sterilized water was added to slake the lime, and the mixture set aside in sterilized bottles for a week. At the end of that time the lime was washed away from the particles of bone which were then placed in culture media. Just as luxurious a growth of organisms resulted as did from control cultures which had not been treated with lime. Gilruth claims that, although in this experiment the germs were *within* the substance of the bones treated, the test was a fair one, in that the lime was as likely to get to a germ in a small ⅛-inch cube of bone as to germs in larger bones, or in hard, clayey nodules of soil, and he points out that, while, at a pinch, equal parts of lime might be added to bones to be disinfected, it would be impracticable to treat the soil with equal parts of quicklime.

So far as concerns the disinfection of bones containing anthrax or other disease germs (and bones imported from India and elsewhere have been responsible for a number of outbreaks of anthrax in Australia and New Zealand during recent years), there are only two effective methods which can be practically applied without commercial loss. One is treatment with sulphuric acid, whereby the bones are chemically converted in soluble superphosphate of lime, the germs being destroyed in the process; and the other is exposure for a few hours to superheated steam, under pressure, whereby the heated steam is forced into the substance of the bone particles, and so contacts and destroys the contained germs.

Of *physical agencies* which act as disinfectants, heat, cold, dryness or desiccation, and sunlight or insolation are the most important. *Heat* has already been adverted to. *Cold* is less effective than heat, but the activities of germs are in large measure destroyed by exposure to a degree of cold, at or below freezing point; or, if the exposure is prolonged, even at a temperature somewhat above freezing point. Just as moisture is essential to the life of germs, as of all living things, so *dryness*, or *desiccation*, is inimical to their development and growth; and hence a long period, or an intense condition of dryness, contributes to the destruction of germ life. For the same reason, disinfection is effected by *sunlight*, or, more correctly, by *insolation*, by which is meant exposure to the sun's rays—the actinic (or chemically active) rays probably, rather than the light rays necessarily. The "sweetening" effects of sunlight are well known, and it would be advantageous if the opportunity were more frequently given for the penetration of sunlight into stables, byres, kennels, and styes.

Of *mechanical means* of disinfection, *filtration* and *sedimentation* are processes by which germ-laden water may be purified, and in this sense they may be regarded as disinfection methods. So also the flushing with

water of drains, floors, walls, and fittings, in so far at it effects the "cleansing" of these or the removal from them of infective matters, may be considered a means of disinfection. In the same sense, *ventilation*, by effecting exchange of air, and *perflation*, or *air-flushing*, by causing the removal of stagnant, devitalized, vitiated, or germ-laden air from a building are auxiliaries to efficient disinfection which should never be neglected.

Internal Disinfection. — Disinfection of the respiratory passages by *inhalation* will be referred to when treating of the parasitic and other lung diseases, but it may be said here that attempts at internal disinfection of the body by the introduction of agents into the alimentary canal, or into the blood direct, have up to the present been illusory; at the same time it would be rash to say that there are no grounds for hope that such a means of protecting the system may be successfully accomplished in the near future.

DISINFECTION OF PREMISES.

The method of disinfection of buildings, yards, and paddocks to be adopted as a means of preventing the extension of communicable disease will depend largely on the nature of the disease and its manner of spreading, whether its cause is a fixed contagion or a volatile or floating infection —that is, whether it is usually conveyed by direct or intermediate contact, as with the contagious anthrax, or by atmospheric contamination also, as in the infectious pleuro-pneumonia.

The period of incubation, by which is meant the time during which, after infection, the disease remains latent before the appearance of symptoms, and the channel of infection—whether by ingestion, inhalation, or inoculation—are also matters which must be taken into account in determining the method of disinfection to be carried out.

When dealing with a so-called infectious disease—that is, where atmospheric contamination or infection has to be counteracted—fumigation of all closeable buildings should be performed. It is necessary, for effective fumigation, that all openings into the building should be effectively closed. Bags may be stuffed into air-holes, louvres, and other openings; and cracks and crevices in doors, floors, and ceilings may be pasted over temporarily with paper. The process will be best illustrated by instancing fumigation with sulphur. Rock brimstone or flour of sulphur is ignited and kept burning by different means, perhaps the most convenient and successful of which is to place the ignited sulphur on an iron plate or shovel, kept at a dull-red heat by the flame of a burning lamp or gas-jet underneath. It may also be vaporized by placing it on top of a layer of live wood or coal ashes on a shovel or iron plate. The building should be kept closed for a period of one or two hours after the sulphur has been burnt. Five pounds' weight of sulphur completely burnt is sufficient to thoroughly disinfect a shed containing 1,000 cubic feet of air space—that is, a building 10 feet by 10 feet by 10 feet. This seems a large quantity of sulphur to use, but accurately-conducted experiments have shown that anything less than 5 per cent. of sulphurous acid gas (SO_2) is inefficient for the destruction of disease germs. If steam is liberated into the compartment at the same time as the sulphur gas, then half the quantity of sulphur will suffice, as the germicidal effect of the gas is more pronounced in the presence of moisture. On the whole, perhaps spraying with formalin is the most effective method of aërial disinfection. A 3 per cent. solution in water is used.

and the finer the spray, and the greater the force with which it is projected into corners and crevices, the better.

Additional measures for the disinfection of buildings comprise the removal of all loose fittings, and the burning of such as cannot be thoroughly cleansed and disinfected with boiling water or otherwise; the burning of all refuse, litter, sweepings, or other *débris* likely to convey infection; the thorough scraping, scouring, and cleansing of walls, floors, ceilings, fixtures, and under side of roof with hot water and soft soap; and the swabbing of all such with a strong disinfectant solution—1 in 1,000 of corrosive sublimate, or 1 in 20 or 40 of carbolic acid, creolin, phenyle, Jeye's fluid, Macdougall's dip, chloride of lime, or caustic soda, in such a way that all crevices and corners and projections are reached by the fluid. The walls and floors may then be painted, or lime-washed with hot carbolized quicklime, or coated with heated tar.

Yards, if paved, shoud be flushed and brushed with a corrosive sublimate solution. If the floor is of earth, the surface mud or soil, to a depth of 6 inches or more, should be spaded off, removed and burnt. The bared surface should then be charred by covering with straw or litter, sprinkled with kerosene, and fired. A thick dressing of quicklime may be applied, and the surface made up with fresh, clean earth, well rammed and graded.

Drains.—Surface drains should be first swept clean, and copiously flushed with water, then flushed with corrosive sublimate solution, and afterwards made impervious by coating with heated tar. The disinfection of underground drains presents greater difficulties. They should be scraped, if possible, and then slowly flushed with a strong solution of caustic potash or caustic soda, after which flushing with water and corrosive sublimate solution may be carried out.

Fences and *walls* of post and rail, pickets, brick and corrugated iron, may be effectively disinfected by first removing all dirt and then swabbing with corrosive sublimate solution, and afterwards coating with hot carbolized lime-wash or with hot tar.

Paddocks are difficult to disinfect, and little effectiveness attaches to the plan usually adopted by treating them with dressings of lime. The only really reliable measure is the giving over of the paddocks to cultivation for a series of years; but, if this is impracticable, the paddocks should be rested until a crop of grass or cereal has been grown, which, when dry, should be fired. Hollows and depressions may be given a heavy lime-dressing with good effect, or they may be sprinkled with carbolic or corrosive sublimate solution. In all cases the surface should be exposed as much as possible to the full effects of a summer's sun.

Water-holes.—The disinfection of water-holes and tanks is likewise a difficult matter. Little more than emptying, cleaning out the mud and sedimentary matters, and dressing the sides and bottom with quicklime or sulphate of iron, can be attempted; and the best plan to adopt in regard to a water-hole known to be infected is, after carrying out the above measures, to fence it round so as to prevent access of stock for a period of about twelve months, by which time, so far as concerns most communicable diseases, the danger of infection will have been reduced to a negligible degree.

Finally, all buildings, yards and paddocks which are known to have become infected with disease germs should not be used for the housing, holding or grazing of any animals of a kind liable to contract the particular

disease in question for a varying period, depending on the virility of the specific germ concerned; and before their ordinary use is resumed they should be tested by allowing susceptible animals of low value to be placed in them for a length of time sufficient to cover the incubation period of the disease.

DISPOSAL OF DEAD ANIMALS.

Closely allied to disinfection is the question of the disposal of the carcasses of dead animals, paricularly those which have been affected with communicable disease.

In Australia there is happily no necessity to discuss the merits of burial *versus* cremation. Except in the large cities, where animal carcasses are usually dealt with at boiling-down or destructor works, there are, as a rule, ample facilities for the burning of carcasses, and this method of disposal is usually adopted—that is, when any method is adopted. For it is unfortunately the case that in many instances no attempt is made to dispose of carcasses; they are simply allowed to rot in the sun where they lie, and are often thus a bountiful source of contamination of water-holes, creeks, and other water supplies. In times past, in regard to pleuro-pneumonia, and even down to the present time in regard to anthrax, this criminally-neglectful custom has been largely responsible for the persistence of these diseases on some properties and along certain of the main stock routes.

A hint as to the construction of the cremation pyre for a bullock or horse may be of service. Immediately alongside the carcass a trench 2 feet wide, 2 feet deep, and 6 or 8 feet long, shallowing towards the ends, should be dug, and filled level with wood. On this and on the adjacent ground at the sides a foot-thick layer of long wood should be piled, and the carcasses rolled on to it and covered above and all round with a sufficient quantity of wood. A sprinkling of kerosene or tar to start the blaze, and replenishment of the wood as required, will complete the job. The advantage of the trench is that it obviates the necessity of lifting the carcass, and as the wood in it burns away, it acts as a draught flue to expedite the combustion and render the cremation complete. Any of the surrounding ground surface that is soiled or soaked with blood or discharges from the dead animal, should be spaded off and thrown on to the fire, and in the case of communicable disease it is also a wise precaution to char the ground for some distance round by sprinkling with kerosene and firing. Whenever possible, carcasses should be cremated where they lie, without removal. Removal always means additional contamination of either vehicles or ground, and this involves extra trouble and expense of disinfection, and increased risk of spread of the disease.

If for any reason burying the carcass is resorted to, the grave should be sufficiently deep that every part of the animal may be at least 3 feet below the ground surface. This will require that the grave be dug at least 6 feet deep. The elbow and stifle joints should be cut through (except in the case of anthrax carcasses), so that the limbs may fall down and fold in to the body. The surface soil on which the carcass has lain should be dug over, plentifully mixed with quicklime, and thrown into the grave round about the carcass before the remainder of the soil is filled in.

Sometimes in the vicinity of chemical manure works, treatment with ti. ulphuric acid is adopted as a means of disposal of carcasses, but, as a mois , destruction by chemical means is impracticable, and expensive beyond metho nt.

Disposal of carcasses by treatment in a destructor, or by boiling down, is frequently resorted to where establishments for the carrying out of such procedure exist near by. Considerable returns may be got from the resulting fat, bones, gelatine, manure and other products, especially in the case of well-conditioned horses and fat cattle or pigs; but where a communicable disease is being dealt with, care needs to be taken that all parts of the carcass, including the skin (which it is better to burn), should be treated, and so rendered innocuous. The vehicle in which the carcass is conveyed to the premises, and all appliances on the premises brought in contact with the carcass, will also require to be efficiently disinfected.

ISOLATION.

Isolation, as a means of preventing the extension of communicable disease, means the separation of the unaffected from contact, both direct and intermediate, with affected animals. The converse plan of removing the diseased animal from the midst of the healthy is a grave mistake, in that it involves the contamination of the hitherto clean buildings, yards, and paddocks to which such diseased stock is removed.

If the animals being dealt with are housed, it is necessary that the buildings in which the diseased animals are should be completely disconnected by drains, air openings, doorways, windows, and in every other way, from any building used for other animals subject to the same disease. If not housed, then the isolation yard, paddock or enclosure must be surrounded by a roadway or double fence, or by other yards, paddocks or enclosures, in which no animals of the same kind are kept; and no communication by drains or other waterways from the isolation paddock must be allowed to exist.

In dealing with infectious diseases—that is, those in which an infected atmosphere may be a means of communication, isolation is not always efficacious, but with purely contagious diseases—those requiring contact for infection—it may usually be relied on. In the latter case, care must be taken that contact does not take place by any intermediary, such as attendants or their clothes; other animals, including rabbits, rats and mice; water; drainage; bedding; utensils, or the like means. Intermediate contact by means of flies and insects is difficult to prevent, but, excepting tick fever, in most cases the probability of such a method of transmission, in Australia at all events, may be considered as remote.

IMMUNITY.

The possession of immunity against, or insusceptibility to, any particular disease is an effective preventative of that disease. Such possession of immunity may be either inherent to the species, or it may be acquired, naturally or artificially, by the individual.

Inherent immunity is possessed by *all* species of animals to *some* diseases. Man is immune against blackleg of bovines, horses against diphtheria of man, cattle against bubonic plague, pigs against scarlet fever, and dogs against typhoid fever. Again, take the diseases of small-pox of man, strangles of horses, contagious pleuro-pneumonia of cattle, lymphatic abscess of sheep, swine fever, and canine distemper. In all these cases the disease is peculiar to the species mentioned. None of them ever affects animals of any other species, which are therefore said to have an inherent or possessed immunity against them. Why certain species or kinds of animal are never

attacked by certain diseases common in other animals similarly circumstanced is a problem that has not yet been satisfactorily solved. It is speculated, however (on the basis of experimental evidence, a large amount of which has been recorded during the past decade) that this natural immunity may be found to depend on four principal agencies, any one of which may possibly determine the insusceptibility as regards some species and some diseases, but all four of which are doubtless factors in the majority of instances of immunity. These agencies are—(1) *Body temperature:* The high temperature of birds normally would appear to account for their resistance to anthrax invasion, for when the body temperature is kept continuously reduced by artificial means, such as immersion in cold water, birds become liable to anthrax equally with other animals. (2) *Germicidal substances* present in the blood serum of the insusceptible animal. Horses are found to possess normally a certain quantity of diphtheritic anti-toxin circulating in the blood. (3) The phenomena which led to Metschnikoff's theory of *phagocytosis*, by which is meant the selective destruction or devouring of particular invading germs by the white blood cells. (4) The *chemical constitution* of the fluids and tissues of the body.

Acquired immunity may be naturally or artificially acquired. The protection afforded by one attack of a disease against subsequent attacks of the same disease is perhaps the best-known illustration of *naturally-acquired immunity*, although the immunity possessed by matured animals against diseases which only develop in the young is also a fairly common instance of the natural acquirement of immunity. Such immunity may be permanent for life, as after strangles in young horses or blackleg in calves, or may be more or less temporary, as is seen in the recurrence in the same animal, at varying periods of remoteness, of tick fever in cattle or swine fever in pigs. One of the first theories advanced to explain this acquirement of protection, whether permanent or temporary, was known as the "pabulum" theory. It was assumed that there was in the system some special substance necessary for the existence of the invading germs, and that this substance, or food, or pabulum, was eaten up or exhausted during the progress of the first attack, and that, therefore, the system was thereafter, either permanently, or temporarily pending slow replenishment, devoid of the material essential to the support of the germ concerned, which consequently, on being introduced to a "recovered" system, could not grow, or multiply, or exert its disease-producing effect. Another hypothesis, and one which was also held to account for the three stages of fever—the premonitory stage, the crisis, and the decline—assumed the excretion by the germs themselves, when active, of a material which was inimical to their further growth and development. In other words, it was assumed that the products elaborated during the activities of germs were poisonous to the germs, and destroyed them, and also any others of the same kind which gained access subsequently—just as the sewage and nightsoil of a town, if not removed, would become fatal to the inhabitants, and when they were decimated would prevent the further occupation of the town by others. Specious as were these speculative explanations, and as were also others that have been advanced from time to time, there were many counter-arguments of a practical character, and it was found that they would not, except incompletely, stand the test of experimental proof.

No reasonably sound explanation, based on experimental evidence, was forthcoming until the development by Metschnikoff of his *phagocytosis*

theory, which has been previously referred to. His investigations showed that the invasion of the system or a part by disease germs induced an enormous increase in numbers of the white cells of the blood, which attacked and destroyed the invading germs. From these facts he deduced that protection against subsequent invasion by the same kind of germ would follow by the preparedness of the system to quickly elaborate an immense force of defending white blood cells, to which, when concerned in this work, he gives the name of "phagocytes." But it would appear, from the still more recent researches of Behring, Katisata, Ehrlich, and others, that Metschnikoff's phagocytes are not the only defenders at hand, but that, in addition, there is a power possessed by the tissues to form, when attacked by disease germs, certain substances called "Anti-toxins," which have the power of antagonizing or neutralizing the toxins or specific poisons produced by germs. It is the toxins or poisons excreted by germs which have the death-dealing properties, and not the germs themselves, and when these toxins are neutralized by the formation of anti-toxin, recovery takes place, and the system apparently retains the protective influence of the anti-toxin or acquires the power of producing it for a greater or lesser period of time or for all time, and is consequently immune against another attack, either temporarily or permanently, as the case may be. The phenomena of toxins and anti-toxins are more marked in some diseases than in others.

Artificially-acquired immunity is brought about by a process of protective inoculation. It has been the habit to apply the term "vaccination" indiscriminately to all methods of protective inoculation, but this term refers particularly to the use of vaccine in protective inoculation against small-pox. A better term is the apt and recently-coined "jennerization,"[1] by which is meant the inoculation of any material with the object of protecting against disease. The process consists in the injection or introduction into the system of (*a*) material (virus), which will set up an allied disease or a mild form of the disease to be counteracted or (*b*) material (anti-toxin) which will counteract or antagonize the toxins produced by the causative germs of the disease.

Virus Inoculation.—In carrying out the first of the above methods, viz., the introduction of a virus for the production of artificial immunity three schemes may be adopted—(1) The inoculation of the ordinary virus of an allied but milder disease, as in the case of vaccination for small-pox in man, in which case the benign cow pox virus is inoculated to protect against the virulent small-pox. In animals the inoculation of avian tuberculosis for the immunization of cattle against bovine tuberculosis is a similar instance. (2) The injection of a weakened or attenuated virus of the same disease to produce a mild and controllable attack of the disease, and so protect against a natural and virulent attack. For example, the use of anthrax virus attenuated by cultivation in an oxygen atmosphere to protect against anthrax invasion. (3) The introduction of the ordinary or full-strength virus of a disease at a part anatomically remote from the natural seat of the disease, and into tissue histologically different from the tissue naturally invaded, whereby a local manifestation of the disease is produced, which can be confined to the adjacent parts, or the spread of which can be controlled. This is exemplified in the practice

[1] After Jenner, who, in regard to small-pox, was the first to introduce the practice of protective inoculation, and who is justly entitled, by the adoption of the term "jennerization," to have his name immortalized as the "father" of the system.

of inoculating cattle for pleuro-pneumonia, when pleuro lymph from the lungs or chest cavity is introduced beneath the skin near the tip of the tail, where it sets up a local inflammatory lesion which, except for the modification occasioned by the difference between the tissues of the tail and lung tissue, is in every way identical with the lesions in the lungs in pleuro-pneumonia, and which does not usually spread beyond the tail, just as pleuro-pneumonia itself does not spread usually beyond the lungs.

Anti-toxin Inoculation.—For the production of artificial immunity by the second method—that in which anti-toxin or anti-toxic material is injected into the blood—the material so injected may be produced by—(*a*) Artificial means, as when anti-diphtheritic serum is produced in the blood of horses; or (*b*) advantage may be taken of the fact that it may be procured from an animal in which it has formed naturally during the currency of an attack of the disease, as when "recovered" blood (*i.e.*, blood from an animal which has recovered from a virulent attack) is injected as a preventative of tick fever, or when bile from an animal suffering from rinderpest is used to protect other animals against an attack of that bovine scourge.

IMMUNITY TABLE.

Immunity

- Inherent
  - Chemical constitution of tissues
  - Phagocytosis
  - Blood germicide
    - Man insusceptible to blackleg of cattle.
    - Horses insusceptible to diphtheria of man.
    - Cattle insusceptible to bubonic plague of man and rodents.
    - Pigs insusceptible to scarlet fever of man.
    - Dogs insusceptible to typhoid fever of man.
  - Body temperature—Birds immune to anthrax.
- Acquired
  - Naturally
    - Permanent
      - previous disease
      - age
        - Blackleg in cattle.
        - Strangles in horses.
    - Temporary
      - previous disease
        - *Swine fever—about six months immunity.*
        - Tick fever in cattle—about one year's immunity.
  - Artifically
    - Virus inoculation
    - Anti-toxin inoculation
      - **Naturally occurring**
        - **In the bile of rinderpest-affected cattle.**
        - **In the blood of cattle recovered from tick fever.**
      - **Artificially produced, *e.g.*, Anti-diphtheritic serum from horses repeatedly inoculated with diphtheria cultures.**
      - **(*a*) Remote inoculation of full-strength virus, *e.g.*, pleuro lymph in bovine pleuro-pneumonia.**
      - **(*b*) Attenuated virus of same disease, *e.g.*, oxygen attenuated cultures for anthrax in sheep and cattle.**
      - **(*c*) Virus of allied disease**
        - **Avian tuberculosis for tuberculosis of cattle.**
        - **Cow-pox vaccine for small-pox in man.**

The preparations of the viruses and anti-toxins just referred to will be dealt with when the diseases which they concern are considered; but it may be here stated that anti-toxins of certain diseases have been shown to exist in the bodies of animals which are inherently immune to the disease. For instance, horses have in their blood-serum the anti-toxin of diphtheria, against which disease they are immune. It is also found that anti-toxins are developed in the blood-serum of animals into which the germs of a disease to which they themselves are not liable are introduced, so that, by repeated inoculation of the horse with the virus of human diphtheria, an increased quantity of diphtheritic anti-toxin is developed in the blood, and may be extracted in the serum and used for the prevention and cure of diphtheria in the human being. Similarly anti-streptococcic serum for the prevention of abscess formation is got from an animal into which repeated doses of streptococcic cultures have been injected.

I have thought that the consideration of the subject of immunity might be made to lend itself to perhaps more graphic expression in tabular form, and for the better fixing in the mind of the above exposition of an admittedly intricate problem, the phases of which are varying from day to day, I have devised the table shown on the opposite page.

EXAMINATION FOR DAIRY SUPERVISORS, MAY, 1906.

REPORT BY THE BOARD OF EXAMINERS.

(*T. Cherry, M.D., M.S., S. S. Cameron, M.R.C.V.S., R. Crowe, and J. Hancock.*)

The first examination for the appointment of supervisors under the Milk and Dairy Supervision Act has just been completed. Two hundred and sixty candidates presented themselves for the examination, and 22 passed. As these examinations will be held at least once a year for some time to come, we think it advisable to publish the following report, which may be of service to future candidates. The examination was divided into three parts—written, oral, and practical—but, in accordance with the spirit of section 9 of the Act, we did not reject any candidate on the written paper alone. We append the questions at the written examination, and one of the best sets of the answers received. These answers are not to be taken as models in all respects, but they will serve to indicate the average standard which every candidate should aim at.

When the Act comes into operation, no modification of its provisions will be allowed. Supervisors appointed by, and responsible to, the municipalities will require to have the same qualifications and pass the same examination as those acting directly for the Department of Agriculture. The main object of the Act is to introduce a large measure of technical education for dairy farmers. Instead, for instance, of supervisors being armed with powers for simply rejecting cream unfit for consumption at the factory, their duty will be to trace it back to the farm, find out and explain to the farmer the cause of its unfitness, and try to induce him to adopt better methods of production.

The Act lays it down definitely that before a man can be appointed as a supervisor, either by a council or the Minister, he has to give satisfactory evidence that he has had *bonâ fide* practical experience in dairying and the allied branches of agriculture, and amongst animals. As examiners, we have interpreted this to mean that it is no use passing a man through the theoretical portion of the examination in the hope that he will gain practical experience afterwards. We laid it down as a rule, in examining candidates, that a man's answers must furnish evidence that he had had practical experience in dairy farming. Suppose a man in the course of examination claimed to have a knowledge of butter manufacture, but had perhaps never seen a butter factory, it would not be long before we would discover that he was solely "book learned" and had had no practical experience of the subject regarding which he claimed knowledge. This process of examination has thrown out the theoretical, or "book," man from the start. The next thing we looked for was a fair general education. In a good many cases we found candidates were so poorly educated that they spelt "*as*" "*has*," and *vice versâ*. We instance this as showing one type of man going up for examination. Although such a lack of education was so manifest, and might have justified us in throwing a man out on the written paper, we allowed him to come to the oral and the practical examination. In every case we had no difficulty in finding that he was weak in his dairying and agricultural knowledge also. It was therefore easy to reject him. Men of this type who have attained the age of 30 or 35 years are hardly the class of men who will make successful supervisors. It shows they have not understood the importance of education, and unless a man has enough grit in him to realize that education nowadays is one of the main factors in life, we hardly think we could reasonably expect he would prove to be the type of man we were looking for. We required, first, practical experience; second, general education; and, third, sound common sense and tact, with a knowledge of the underlying principles of agriculture—men who could not only do a thing, but who could say why they did it, and who were also able to explain their reasons lucidly to a farmer. For instance, when we asked why lucerne hay was of more value to the dairy farmer than, say, mangels, we did not expect him to go into elaborate details as to the amount of protein the hay contained. We expected he would give an answer more after the style of that printed below.

With regard to the practical examination, the first thing that struck us was the large proportion of the candidates who had been labouring under the great disadvantage of having received no special instruction in farm methods, and in matters which are of importance to every farmer. A large number exhibited a great lack of discrimination between the little unimportant details and the great principles of which every one should have a firm grip. Many of the candidates were men of a decidedly superior type; they were far and away above the average young farmer. Most of the candidates were men between 25 and 40 years of age. As examiners, the impression we obtained, after hearing the experience they had had on their own farms, was that there are a large number of farms in Victoria where sound methods are being carried out, and which may very well serve as models for the neighbourhood. Few candidates had had any guidance with regard to their ways of thinking. Their facts have been accumulated from experience, but their judgments in most cases have been formed wholly without having any one with whom they

could discuss the facts they had been thinking about. Another type we met with was a man who had got hold of a fair number of facts which were correct, but at the same time was hugging a number of delusions and calling them facts. This was apparently chiefly owing to the disadvantage of not having had any one to assist him in sifting the true from the false. Very often he was cocksure about being right, when, as a matter of fact, he was absolutely wrong. In dealing with men of this kind we were largely guided by their type of mind. If we found a man was in the habit of thinking, and reflecting and bringing common sense to bear on his answers, and if he was willing to admit he was mistaken, we sent him on for further examination; but when we met the type of man who was wrong in a good number of facts, who was absolutely sure he was right, and who would not admit that he might be mistaken, we simply rejected him at the oral examination. He is not the man to make a good supervisor. At the abattoirs we threw out a man for the reason that, although, as far his knowledge was concerned, he was up to the average of those who passed, yet there were points about his methods that were fatal. In examining one of the cows he percussed it, and when asked what he could hear he said he had a bad cold, and could not hear anything. Later on we asked him to give instructions to the attendant as to what to do when cleaning the yards after leaving the place. There had been a number of cows suffering from tuberculosis and other infectious diseases in the pen, and in examining the animals he had got a fair amount of infective material on his hands. He gave excellent instructions as to what was to be done with the floors, but before he finished speaking to the attendant he picked up his coat and put it on without washing his hands, or taking any further thought, showing there was a lamentable lack of harmony between his theory and practice. At a later stage, although he was unable to tell what some ordinary specimens were, he remarked that he would guarantee he could diagnose by *post-mortem* appearances anthrax, with any man in Australia. There is no man who can diagnose anthrax simply by a *post-mortem* examination. These incidents revealed the type of man we had before us, and we were unable to let him go any further. A number of candidates were foolish enough to pretend to a knowledge or experience that they did not possess. This was particularly the case with those who attempted to "sound" a cow's chest by auscultation and percussion. The sort of man who would be unwise enough to try to delude his examiners would scarcely to reliable in his intercourse with farmers or in the carrying out of the responsible duties imposed on supervisors under the Act. Some candidates, although they got up their work well, displayed a great want of reliance on the methods they were advising. For instance, we would ask a man what he would do with a pig, which had died of swine fever. He said he would tell the farmer to burn it. We asked him what about the ashes of the pig. He said he would tell the farmer to bury the ashes 6 feet deep, and put a bag of quicklime on top of them. It was obvious he could not have much faith in his burning if the ashes needed to be so carefully dealt with. What we objected to was a man giving elaborate instructions of that sort, and not being able to justify his action in putting the farmer to such a lot of unnecessary work. Unless candidates have their knowledge balanced, it is quite certain that if they are turned loose amongst the farmers as supervisors, they will bring ridicule upon the whole administration of the Act. Now, the most

important thing in the practical examination is care in arriving at conclusions. Take, for instance, the examination of cows. We want a man to look at them carefully all over, and, while we do not expect every one to give them the same overhauling as a veterinary surgeon would, we want them to be examined so carefully that none of the big outstanding points are missed. A good many candidates simply looked at the cow from one side only, or noted some prominent point, and then jumped at a conclusion. At the practical examination it was simply surprising the number of men who failed to observe that two of the cows examined on had blind quarters. On the other hand, there were some who displayed great care in arriving at the facts of the case. When shown a simple case, which one would have thought could have been recognised at a glance, they looked into it carefully, touched and handled it, and thought about it before saying what it was. They exhibited equal care with the difficult specimens, and simply from the way in which they looked carefully into all the facts, and turned over these facts in their minds before coming to a conclusion, we felt they were exactly the type of men to induce farmers to improve their methods.

Amongst the older men who presented themselves we found that the great stumbling block to their becoming good supervisors was their inability to give up cherished fallacies. They relied largely on their experience of methods that were oftentimes obviously improper. Many of them gave us the impression that they would have a lot to unlearn, and that the unloading of their present conceptions would be but slowly and reluctantly accomplished.

We hope in the future to make the examinations even more practical than they are at the present time. Instead of confining the practical work to the examination of live animals and dead specimens, we hope to be able to make arrangement, by means of which we will have facilities on a good farm to give every one who goes up for examination an opportunity of showing what he knows of all the operations connected with farming. For instance, we would like to see how some candidates set to work to wash a cow's udder. From the way in which the question was answered, there seems to be a great difference of opinion existing in the minds of many as to the proper way of doing a simple thing like this.

For the information of any who are thinking of going up for future examinations, we would like to mention a few points. The type of man we want as supervisor, with the experience he has behind him, should be too good to remain the whole of his life at £150 or £200 a year. The Department has announced that in the case of good service and progressive efficiency it will raise the salary of a supervisor £25 a year. So far a maximum salary has not been fixed. Under the provisions of the Act it will not be possible to go much above £200, otherwise the expense to the farmer would be too great, because the salary has to be covered by the fees. We want men who look forward to being dairy farmers themselves, and who will make their farms models for the surrounding districts to copy.

Owing to the fact that the first examination had to take place within four months of the time that the Act was passed, it was practically useless for the Department to attempt to do anything in the way of arranging for the tuition of candidates. The amount of polish you can give to a

candidate in two or three months is not of any great importance in an examination of this kind. Now that the first examination is over, and as examinations will recur at regular intervals from this time forward, it has been felt that some steps should be taken to institute classes for the necessary teaching in the principles which underlie sound dairy farming practice, and instruction in the most important parts of the routine duties which supervisors will have to undertake. The Department has accordingly opened up negotiations with the University to arrange for carrying out this side of the education of the supervisors, and a five months' course of instruction will be established almost immediately This instruction will embody the practical work of the dairy farm, the main points connected with bacteriology, physiology, and veterinary work, and the hygiene of the farm. These subjects will be treated by lectures and demonstrations very much in the same style as those held in connexion with the bacteriology classes for butter factory managers. We hope that by this course the candidates who have already had a good practical experience will be more thoroughly equipped from every stand-point, and better prepared, not only for the examinations, but for undertaking the active work of supervisors as soon as they may be appointed under the Act.

NOTE BY MR. HANCOCK.

As the one examiner outside the Department of Agriculture, I would like to add my impressions of the examination and its possible results.

Like a number of the farmers of the State I had been imbued with the idea that the dairy farmers had much to dread from Government dairy inspection, but, after being in close contact with the officers of the Department during a very arduous fortnight, and ascertaining what their aims are, I am now convinced that if the supervisors do their work in accordance with the wishes of the Department they (the farmers) will have nothing to fear.

One good point is that whether the Act is carried out by the Department or by the municipal councils, there will be uniformity of inspection.

QUESTIONS AND ANSWERS.

Question No. 1.—*State, in detail, why it is advantageous to cool and aerate milk for a town supply immediately on being drawn.*

Milk as it is drawn from the cow contains a large number of substances of a volatile nature, which depend largely upon the variety of feed she has been eating; for a number of foods give a characteristic, and in some cases disagreeable, odour and taste. In addition to these, there is the characteristic animal odour itself dependent upon the cow, in some cases very strong and objectionable. All these are volatile, and if the surface of the milk can be increased and brought in contact with the air, these substances volatilize or pass off readily, and leave a pure tasting and smelling milk. This condition can be brought about by aerating the milk over a special apparatus, with which is conjoined the power of cooling.

This cooling is particularly advantageous, for the temperature of fresh milk is one in which lactic acid bacilli are active, and the milk will thus

more quickly turn sour, or at least have a greater acidity than that allowable. By cooling the milk the development of these bacilli is checked, and if the milk can be kept at a low temperature until delivery very little acidity will be present, and practically sweet milk will be delivered. So far, at least, as children are concerned, this is most important.

Question No. 2.—*Describe the essential features of the floor of a byre or cow-shed. (Rough drawings should be given to illustrate your answer.)*

The essential features of the floor of a byre are—(1) That it shall be impervious to moisture; (2) that it should be perfectly drained and easily cleansed. The method of obtaining the first depends upon the material available in the district, and may be either bricks well set in cement, pitchers, or stones available set in cement, and levelled off with a surface coat of the same material, or tar and sand, or a floor of wood, set and covered with the same materials, may be used.

The second is obtained by grading. The stalls should have a slight fall from front to rear, then a sudden drop should be given to form the gutter, which should have a fall of about 1 inch in 20 feet from end to end of the shed to the outlet. From the wall of the drain a gradual rise should occur to the crown of the passage behind, as shown in the diagram No. 1, or the drain may have a square bottom, as in No. 2. For double rows the same scheme should be carried out on the other side.

Whatever system is followed, it is essential to have a firm foundation of puddled clay, if possible, with a good solid layer of stones, concrete, &c.

(Explanatory sketches accompanied this answer.)

Question No. 3.—*What are the most common causes of a sudden and considerable diminution of milk yield in a herd of cows?*

The most common causes of a sudden and considerable diminution of the milk yield in a herd may be—Sudden changes of weather and exposure to cold; sudden change of feed; eating deleterious material; excessive excitement, as by being rushed in by a dog; change of milking shed; outbreak of specific infective disease; and sudden shortage of drinking water.

Question No. 4.—*Indicate your ideas of the respective advantages of the following fodders in the feeding of dairy cows, and state your reasons:—(a) Wheat bran; (b) oaten straw; (c) mangels; (d) green maize (three months' growth).*

In feeding dairy cows certain principles must always be borne in mind—1st, that a certain amount of dry material is necessary; 2nd, that a certain amount of nitrogenous, proteid, or albumenous material is necessary; 3rd, a certain amount of carbohydrates; 4th, a certain amount of hydrocarbons or fats; 5th, a certain amount of salts and water. In the substances under notice wheat bran is advantageous on account of the proteid contained, its nitrogenous ratio being high. Oaten straw supplies a small amount of the proximate constituents, but largely represents the dry matter. Mangels consist largely of water, the solid material of them representing the carbohydrates mainly. Green maize is a fairly representative fodder of all the constituents, but by itself has too much water.

The fats are present to a variable degree in all the fodders, and are capable of being formed in the body from the non-nitrogenous portion

of the proteids, and to a certain extent from carbohydrates, though how this change is brought about is not clearly demonstrated.

A mixture, then, of the above-named foods is seen to be advantageous. Separately, green maize stands first; wheat bran, plus water and chaff, second; oat straw, third; and mangels by themselves would be of little value.

(*Examiners' Note.*—This answer is much too general. By that we mean that a farmer unacquainted with the subject could not extract much information out of the answer that would be of practical use to him in the compounding of a ration from the feed stuffs named.)

Question No. 5.—*How would you distinguish between a tuberculous udder and an inflamed one?*

Inflammation of the udder is primarily distinguished from tubercle by the fact that the former is sudden in appearance compared to tubercle.

An inflamed udder is swollen, tender to touch or absolutely painful, depending upon the extent of the affection; the swelling is uniform in the quarter affected or in the whole gland; secretion of milk is arrested, and a fluid of a clear nature, resembling whey, along with coagulated flakes resembling curd, may be obtained from the teats; or, depending upon the severity of the case, a purulent discharge may be present. In fact, any degree, from serous exudate to fœtid pus, may be found.

In tuberculosis the onset is never sudden. The gland may become swollen, but the swelling is irregular, hard, knotty, painless, irregularly situated in regard to quarter or gland, according to the number of foci. The secretion of milk, unfortunately, is not affected, except in advanced cases. When invasion of the gland is advanced and various centres are breaking down, then the milk may be tinged with blood, and be thick from escaping pus and disintegrated gland substance.

Question No. 6.—*Write what you know about contagious abortion in cattle, and briefly detail the measures necessary to prevent its spread.*

Contagious abortion in cattle is a specific infective disease, due to a bacillus. It is of a fixed nature, remaining on a farm for some time, and may be introduced by bringing diseased animals into a herd or by attendants.

It consists of a specific catarrh of the mucous membrane of the womb, infection usually taking place through the vagina. The period of incubation varies from one to ten weeks, or longer, and the first visible sign of trouble is the appearance of a discharge from the vagina. Within three days abortion usually takes place, and is brought about by the appearance of a serous exudate between the walls of the uterus and the fœtal membranes. A discharge continues after this, and may continue for a considerable period and produce great weakness.

To prevent the spread of the disease the fœtus and membranes must be burnt, then the parts of the cow which have been in contact, tail, hips, openings, mammary gland, or the whole body if necessary, must be washed in some antiseptic, as carbolic acid, 1 in 40; perchloride of mercury, 1 in 1,000; lysol, creolin, &c. The vagina and uterus must be washed out with the same substances in weaker strength at first, say mercury, 1 in 2,000, after calving, which may be increased in strength to 1 in 1,200 or 1,500.

All woodwork should be scraped, then washed with water as hot as can be managed, in which washing soda is dissolved, and then painted all

over with limewash containing carbolic acid, 1 lb. to 4 or 5 gallons, or simply painted with carbolic lotion or perchloride of mercury. This latter must not follow the soda wash, as it would be valueless.

The soil in contact with membranes, fœtus, or discharge should be burnt over, then dressed with quicklime and turned over.

The bull must have the sheath and penis syringed out with the perchloride lotion.

(*Examiners' Note.*—The candidate failed to mention the necessity for isolation of aborted cows, or injection treatment of all the cows in the herd whether aborted or not, and whether in calf or not, and for the non-use, for a period of three months, of the bull that has served aborted cows.)

Question No. 7.—*Describe, in detail, the methods you would adopt, and the agents you would use, to cleanse a milk-room that has become sour.*

To cleanse a milk-room that has become sour, every part of it—walls, floor, ceiling, doors, and windows, and all utensils in it—must be scrubbed out with a solution of washing soda in boiling water, washed all over with a solution of formalin in water, and afterwards limewashed. In case of a large building, the antiseptic or limewash may be applied by means of a spray pump, and a plentiful supply of fresh air and sunlight admitted.

Question No. 8.—*What steps would you take to locate the cause of a fault in butter, if deputed to visit a butter factory:*

To locate a fault in butter, the first step is to commence at the source of the butter—that is, the cow. A preliminary examination of the factory may be made, but by carefully inquiring into the method of treatment and management of the cow, cow-shed, milk-room, and all appliances on the farm, the method of carriage to the factory, and then carefully tracing the product through its various stages, examining all utensils, noting all temperatures, the degree of acidity present in cream, the method of handling, packing, and storing, the ventilation, drainage, and the water supply, the condition of all outbuildings, &c., the fault, of whatever nature, can be located.

(*Examiners' Note.*—Fuller details should have been given in regard to the method of overhauling the factory.)

SUCCESSFUL CANDIDATES.

The following are the successful candidates :—

Baker, G. H.	Hamilton, R.	McKenzie, G.
Besley, A.	Harmer, G.	Reeves, S. A.
Bethune, A. D.	Harrison, C. K.	Robertson, W. A. N.
Burrage, T. A.	Holt, H.	Ross, A. J.
Christensen, D. N.	Molan, P. J.	Ryland, E.
Comans, M.	Morris, E. G.	Sherlock, S.
Connor, J. M. B.	McFadzean, J. S.	Younger, W.
Gordon, G. S.		

Of the 22 successful candidates, 10 are dairy farmers, 5 factory managers, 3 veterinary surgeons, 1 an analyst, 1 a shire inspector, 1 an inspector of the Agricultural Department, and 1 a dairy hand. They range in age from 20 to 44, the average being about 35.